RESTRICTED

ORDNANCE PAMPHLET NO. 1040
(PRELIMINARY)

GUN SIGHT
MARK 14, MOD. 6, 7 AND 8

OPERATOR'S MANUAL

A BUREAU OF ORDNANCE PUBLICATION . . . . . ISSUED DECEMBER 1943

ADDENDA TO O.P. 1040 PRELIMINARY

INSTRUCTIONS PERTAINING TO MK. 14, MOD. 12, 13 AND 14 GUN SIGHTS

FOREWORD

1. O.P. 1040 Preliminary, Operator's Manual on Gun Sight Mk. 14, Mod. 6, 7 and 8 is applicable also to Gun Sight Mk. 14, Mod. 12, 13 and 14, except for minor modifications given in this addenda.

2. Instructions given in the addenda are supplementary to instructions covered in the manual, hence, in the addenda a reference is made in each paragraph as to which part of the manual it is a supplement.

3. In cases where the supplement is part of a table, the heading of the table is repeated in the addenda, to avoid confusion. (Tables in paragraphs 5, 12 and 19 do not appear in the manual.)

4. To simplify the use of the addenda, Gun Sights Mk. 14, Mod. 12, 13 and Mod. 14 are treated separately, each under its appropriate heading.

MOD. 12 GUN SIGHT

5. (Addition to para. 13, page 8.) Gun Sight Mk. 14, Mod. 12 is mounted on Gun Director Mk. 51 for control of 3-inch, 50 caliber antiaircraft guns. The Mod. 12 sight is designed to operate at ranges between 400 and 3600 yards. It may be used, with reduced accuracy, at ranges greater than 3600 yards. When it is so used, an arbitrary spot in elevation should be introduced, by means of the elevation spotting knob, to compensate for the increased sight angle (superelevation) required at the longer ranges. A table of suggested spotting corrections is listed below.

Actual Slant Range, Yards	Sight Range Setting	Time of Flight, Seconds	Elevation Spotting Correction, mils.
8000	3600	18.43	Up 25
7500	3600	16.61	Up 25
7000	3600	14.89	Up 25
6500	3600	13.26	Up 25
6000	3600	11.71	Up 25
5500	3600	10.26	Up 25
5000	3600	8.89	Up 25
4500	3600	7.62	Up 20
4000	3600	6.45	Up 11
3600	3600	5.58	0

6. (Addition to para. 14, page 8.) The complete gun sight equipment for the 3-inch, 50 caliber antiaircraft gun is the same as that listed for the 1.1-inch gun on

page 9, except for the following two items:

(a) Gun Sight Mk. 14, Mod. 12 is furnished instead of Gun Sight Mk.14, Mod.7.

(b) Spare Parts Box and Parts Bu. Ord. No. 325816- -1 is furnished instead of Bu. Ord. No. 325729- -1.

7. Reticle. The Mod. 12 sight uses the same type reticle as the Mod. 7 and 8 sights. This is shown in figure 6 on page 27 of the manual.

8. (Addition to SUPERELEVATION TABLE following paragraph 46 on page 31.)

Range in Yards

Gun Sight Mark 14	Median Value	Shift to	Reticle Should Move	
Mod. 12	1800	400	12 mils (up)	A
		3600	18 mils (down)	B

9. (Addition to table in paragraph 53, page 32.)

Gun Sight Mk. 14, Mod.:	Range Setting, Yards	Characteristic Time, Seconds Room Temp. (65°-85°F) Min.	Max.	Extreme Temp. (0° or 100°F) Min.	Max.
12	3600	6.4	6.9	5.9	7.4

10. (Addition to table in paragraph 62 on page 33.)

Gun Sight Mk. 14, Mod.:	For Use with Gun	Set Range Knob at Median Range Listed (yds.)
12	3-inch, 50 cal.	1800

11. (Addition to para. 32, page 53.) In the case of the Mk. 14, Mod. 12 Gun Sight a detent is engaged at each 200 yard interval.

MOD. 13 GUN SIGHT

12. (Addition to para. 13, page 8.) Gun Sight Mk. 14, Mod. 13 is mounted on Gun Director Mk. 51 for control of 5-inch 25 caliber guns. The Mod. 13 sight is designed to operate at ranges between 400 and 3000 yards. It may be used, with reduced accuracy, against incoming targets at ranges greater than 3000 yards. When it is so used, an arbitrary spot in elevation should be introduced, by means of the elevation spotting knob, to compensate for the increased sight angle (superelevation) required at the longer ranges. A table of suggested spotting corrections is listed in this paragraph.

Actual Slant Range, Yards	Sight Range Setting	Time of Flight, Seconds	Elevation Spotting Correction, mils
5000	3000	9.49	Up 25
4500	3000	8.29	Up 25
4000	3000	7.11	Up 20
3500	3000	6.02	Up 11
3000	3000	5.00	0

13. (Addition to para. 14, page 8.) The complete gun sight equipment for the 5-inch, 25 caliber gun is the same as that for the 1.1-inch gun listed on page 9, except for the following two items:

(a) Gun Sight Mk. 14, Mod. 13 is furnished instead of Gun Sight Mk. 14, Mod.7.

(b) Spare Parts Box and Parts Bu. Ord. No. 325809- -1 is furnished instead of Bu. Ord. No. 325729- -1.

14. Reticle. The Mod. 13 sight uses the same type reticle as the Mod. 7 and 8 sights. This is shown in figure 6 on page 27 of the manual.

15. (Addition to SUPERELEVATION TABLE following paragraph 46 on page 31.)

Gun Sight Mark 14	Range in Yards: Median Value	Shift to	Reticle Should Move	
Mod. 13	1400	400	11.5 mils (up)	A
		3000	21.5 mils (down)	B

16. (Addition to table in para. 53, on page 32.)

Gun Sight Mk. 14, Mod.:	Range Setting, Yards	Characteristic Time, Seconds: Room Temp. (65°-85°F) Min.	Room Temp. (65°-85°F) Max.	Extreme Temp. (0° or 100°F) Min.	Extreme Temp. (0° or 100°F) Max.
13	3000	6.2	6.7	5.7	7.2

17. (Addition to table in para. 62, on page 33.)

Gun Sight Mk. 14, Mod.:	For Use With Gun	Set Range Knob at Median Range Listed (yds.)
13	5-inch, 25 cal.	1400

18. (Addition to para. 32, page 53.) In the case of the Mk. 14, Mod. 13 Gun Sight a detent is engaged at each 200 yard interval.

MOD. 14 GUN SIGHT

19. (Addition to para. 13, page 8.) Gun Sight Mk. 14, Mod. 14 is mounted on Gun Director Mk. 51 for control of 5-inch, 38 caliber guns. The Mod. 14 sight is designed to operate at ranges between 400 and 4000 yards. It may be used, with reduced accuracy, at ranges greater than 4000 yards. When it is so used, an arbitrary spot in elevation should be introduced, by means of the elevation spotting knob, to compensate for the increased sight angle (superelevation) required at the longer ranges. A table of suggested spotting corrections is listed below.

Actual Slant Range, Yards	Sight Range Setting	Time of Flight, Seconds	Elevation Spotting Correction, mils.
8000	4000	14.73	Up 25
7000	4000	12.06	Up 25
6000	4000	9.67	Up 25
5500	4000	8.58	Up 25
5000	4000	7.56	Up 20
4500	4000	6.61	Up 12
4000	4000	5.71	0

20. (Addition to para. 14, page 8.) The complete gun sight equipment for the 5-inch, 38 caliber gun is the same as that for the 1.1 inch gun listed on page 9, except for the following two items:

(a) Gun Sight Mk.14, Mod.14 is furnished instead of Gun Sight Mk.14, Mod. 7.

(b) Spare Parts Box and Parts Bu. Ord. No. 325813- -1 is furnished instead of Bu. Ord. No. 325729- -1.

21. Reticle. The Mod. 14 sight uses the same type of reticle as the Mod. 7 and 8 sights. This is shown in figure 6 on page 27 of the manual.

22. (Addition to SUPERELEVATION TABLE following paragraph 46 on page 31.)

Gun Sight Mark 14	Range in Yards: Median Value	Shift to	Reticle Should Move	
Mod. 14	2000	400	12.5 mils (up)	A
		4000	18 mils (down)	B

23. (Addition to table in para. 53, on page 32.)

Gun Sight Mk. 14, Mod.:	Range Setting, Yards	Characteristic Time, Seconds: Room Temp. (65°-85°F) Min.	Room Temp. (65°-85°F) Max.	Extreme Temp. (0° or 100°F) Min.	Extreme Temp. (0° or 100°F) Max.
14	4000	6.5	7.0	6.0	7.5

24. (Addition to table in para. 62 on page 33.)

Gun Sight Mk. 14, Mod.:	For Use With Gun	Set Range Knob at Median Range Listed (yds)
14	5-inch, 38 cal.	2000

25. (Addition to para. 32, page 53.) In the case of the Mk. 14, Mod. 14 Gun Sight a detent is engaged at each 200 yard interval.

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GUN SIGHT
MARK 14, MOD. 6, 7 AND 8

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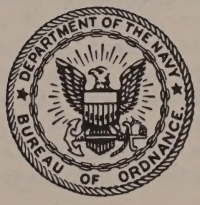

DECEMBER, 1943

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WASHINGTON, D. C.

RESTRICTED

November 1943

ORDNANCE PAMPHLET NO. 1040, PRELIMINARY

GUN SIGHT MARK 14, MODS. 6, 7 and 8.

1. Ordnance Pamphlet No. 1040, Preliminary, contains a general and detailed description of the Gun Sight Mark 14, Mods. 6, 7 and 8, complete with power units, together with provisional instructions for the installation, operation and maintenance of the equipment. Gun Sight Mark 14, Mods. 6, 7 and 8 are the re-designed versions of Gun Sight Mark 14, Mods. 2, 3 and 4. The design changes primarily affect the mechanical arrangement and assembly of the equipments; the use and operation remain essentially the same.

2. This pamphlet is issued in preliminary form for early distribution with the equipment.

3. This publication is RESTRICTED and should be handled in accordance with the provisions of Article 76, U. S. Navy Regulations 1920.

W. H. P. BLANDY
Rear Admiral, U. S. Navy
Chief of the Bureau of Ordnance

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CHAPTER I

- GENERAL DESCRIPTION -

1. NOTE: The following paragraphs present a brief description of Gun Sight Mark 14. For details of construction refer to Chapter VI.

2. Gun Sight Mark 14 is designed particularly for directing the fire of automatic weapons at short ranges against rapidly moving targets such as dive bombers, torpedo planes, and motor torpedo boats. The sight is usable also when firing on slow-moving or fixed targets.

3. Gun Sight Mark 14 is especially suited for use on shipboard, since no stabilized reference plane is required. Provided that the operator tracks a target accurately and smoothly, the action of the sight is not affected appreciably by roll, pitch, yaw, or linear acceleration of the ship.

4. In the gun sight, the line of sight is indicated by an illuminated reticle (the reticle is shown in figures 6 and 18). As the gunner swings the gun so as to hold the reticle on the target, an angular displacement or lead angle is generated between the line of sight and the line of fire. This lead angle compensates for target movement during the time of flight of the projectile.

5. The upper portion of the sight case contains a front window and a back window through which the operator observes the target. By means of two mirrors, one of clear glass and the other silvered, the illuminated reticle is superimposed upon the field of view. As the sight is moved by the operator to track the target, two air-driven gyro units, within the case, are caused to precess. The gyro units control the position of the two mirrors through a lever system. Movement of the mirrors displaces the line of sight (as indicated by the reticle) in deflection and elevation to produce the required lead angle.

6. The brightness of the reticle can be adjusted to suit various target backgrounds. A polarizing light filter is arranged on the inside of the case so that it may be swung into the field of view, to reduce sun glare and water reflection. The filter is neutral gray in color.

7. Range data, supplied by visual estimation or from other sources, is set into the sight by a second man who stands at the right of the gunner. This man actuates the range knob on the right side of the gun sight.

8. Two spotting knobs on the right side of the gun sight are provided for introducing an initial correction for wind and drift; the knobs are used also for putting in spots during firing, if required, in deflection and elevation.

9. Smoothing action (damping) is incorporated into the sight to help the gunner track the target, and to minimize the effect of vibration and jerky tracking. Smooth, even tracking of the target by the gunner is the most important single factor in obtaining satisfactory results with the sight.

10. The sight automatically provides a superelevation correction which varies with range and gun elevation. The correction has the required value regardless of roll and pitch of the ship, because of the interaction of the two gyro units.

11. In the gun sight,no attempt is made to correct automatically for wind,drift, parallax, or roller-path error, since these corrections are usually small at the ranges at which the sight operates. Correction for any of these factors may be made manually by means of the spotting knobs previously mentioned.

12. The two gyro units in the sight are driven by clean dry air supplied from a small power unit mounted on the splinter shield of the 20 mm gun (or supported on the assembly of Gun Director Mk. 51; see next paragraph). The ship's 115 volt, 60 cycle, single phase, a-c supply drives an air pump, in the power unit, and by means of a transformer within the power unit casing, delivers 10 volt a-c to the reticle lamp in the sight. Also, the ship's supply is furnished unchanged (at 115 volts a-c) through suitable connections within the power unit, to the heater circuit in the sight.

13. There are three modifications of the gun sight, as listed below. The modifications differ only in that they provide for the different ballistics of the guns with which they are used.

Gun Sight Mk. 14,Mod. 6 is used with the 20 mm antiaircraft gun, and is mounted directly on the gun cradle. See figure 1. This sight has a maximum range of 2000 yards.

Gun Sight Mk. 14, Mod. 7 is mounted on Gun Director Mk. 51. See figure 1 of the Gun Director instruction booklet, O.D. 4424. The Director is located a short distance from the 1.1 inch guns which it controls. The Mod. 7 sight has a maximum range of 2800 yards.

Gun Sight Mk. 14, Mod. 8 is likewise mounted on Gun Director Mk. 51, for the control of 40 mm guns. The Mod. 8 sight has a maximum range of 3200 yards.

14. The complete gun sight equipment consists of units as listed on the next page.

GUN SIGHT MK. 14 EQUIPMENT

	Bureau of Ordnance Numbers		
	For 20 mm Gun	For 1.1 in. Gun	For 40 mm Gun
Gun Sight Mk. 14, Mod. 6	325713- -1		
Gun Sight Mk. 14, Mod. 7		325714- -1	
Gun Sight Mk. 14, Mod. 8			325715- -1
Each of the above Bu. Ord. numbers covers the complete Gun Sight assembly and the following additional parts:			
Air Hose - 2 (Sight to Power Unit)	325559- -1	325412- -2	325412- -2
Electric Cable (Sight to Power Unit)	325559- -2	325412- -1	325412- -1
Electric Cable (Power Unit to Source)	325352- -1		
Boresight Tube Assembly	325407- -3	325407- -3	325407- -3
Gun Sight Carrying Case	325916- -1	325951- -1	325949- -1
Power Unit	325351- -1	325351- -1	325351- -1
Accessories	325416- -1		
This number includes the following items:			
Gun Sight Bracket and Attaching Hardware	325341- -1		
Gun Sight Bracket, Detail	325342- -1		
Power Unit Bracket, Detail	325417- -1		
Cable and Hose Supporting Bracket	325560- -1		
Spare Parts Box and Parts	325728- -1	325729- -1	325730- -1
Gun Director Mk. 51, Mod. 2		325265-A-1	325265-A-1
The above Bu. Ord. number covers the complete Director Assembly and the following additional parts:			
Electric Cable (Power Unit to Director)		325279- -3	325279- -3
Power Unit Bracket		325340- -1	325340- -1
Gun Sight Bracket		325283-A-1	325283-A-1

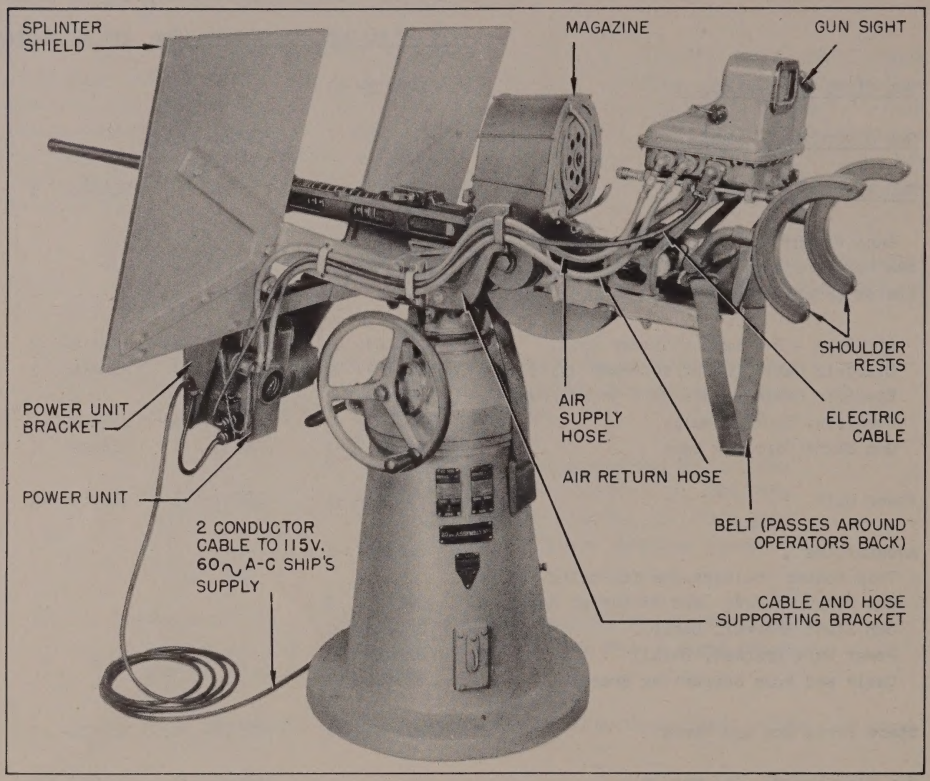


FIGURE 1

GUN SIGHT AND POWER UNIT

MOUNTED ON 20 MM GUN

CHAPTER II

- INSTALLATION -

1. NOTE: Installation instructions as given in this booklet pertain in general to Gun Sight Mk. 14, Mod. 6, used on the 20 mm antiaircraft gun. Where indicated, they pertain also to the Mk. 14, Mod. 7 and Mod. 8 sights, used with Gun Director Mk. 51. Additional installation directions for the Mod. 7 and Mod. 8 sights are given in the director instruction booklet, O.D. No. 4424.

2. The gun sight is mounted on the 20 mm gun by means of a gun sight bracket (Bu. Ord. No. 325342- -1 or 325345- -1) which is rigidly attached to the gun cradle (figure 1). The gun sight bracket must be bolted solidly to properly aligned flat surfaces on the gun cradle.

3. The 20 mm guns are built with flat machined surfaces, on the gun cradle, designed for the gun sight bracket. However, on certain older models it is necessary to weld suitable flat plates. Instructions for this process are given in ORDALT No. 1186. A brief resume of the instructions is presented in paragraphs 4 - 7.

4. Four mounting pads, preferably cold rolled steel, are required. These should be 0.40 inch thick and 1-1/4 inch in diameter.

5. Remove the cradle from the gun and rough grind 4 circular areas, in preparation for welding the pads in place.

6. Weld the mounting pads in place. The gun cradle consists of a steel shell filled with lead. Extreme care must be exercised when welding so as not to melt this lead. Electric arc welding is recommended.

7. After welding, the pads must be machined so that the surfaces are in a common plane, and parallel to the gun keyways in the gun cradle within 10 minutes. The finished height, below the gun bore centerline, is 1.34 ± 0.01 inch.

8. Four holes must be drilled in the cradle, through the pads. The location of these holes is shown on Sketch 111237 which is furnished with ORDALT No. 1186. The two forward holes are located 8.22 inches aft of the trunnions; these are drilled 31/64 inch and reamed to 1/2 inch. The two aft holes are located 11.67 inches aft of the trunnions; these are drilled 17/32 inch. When the holes are finished, the cradle is replaced on the gun.

9. The installation procedure has been developed to facilitate replacement of the sight, and the work of boresighting. The latter has been divided into two parts. First, the gun sight bracket is boresighted with the gun, by means of a boresight tube (see under next heading). Second, the gun sight reticle is lined up with the boresight tube (see Boresighting Gun Sight, page 32). Whenever a gun sight is replaced both parts of the boresighting should be carried out.

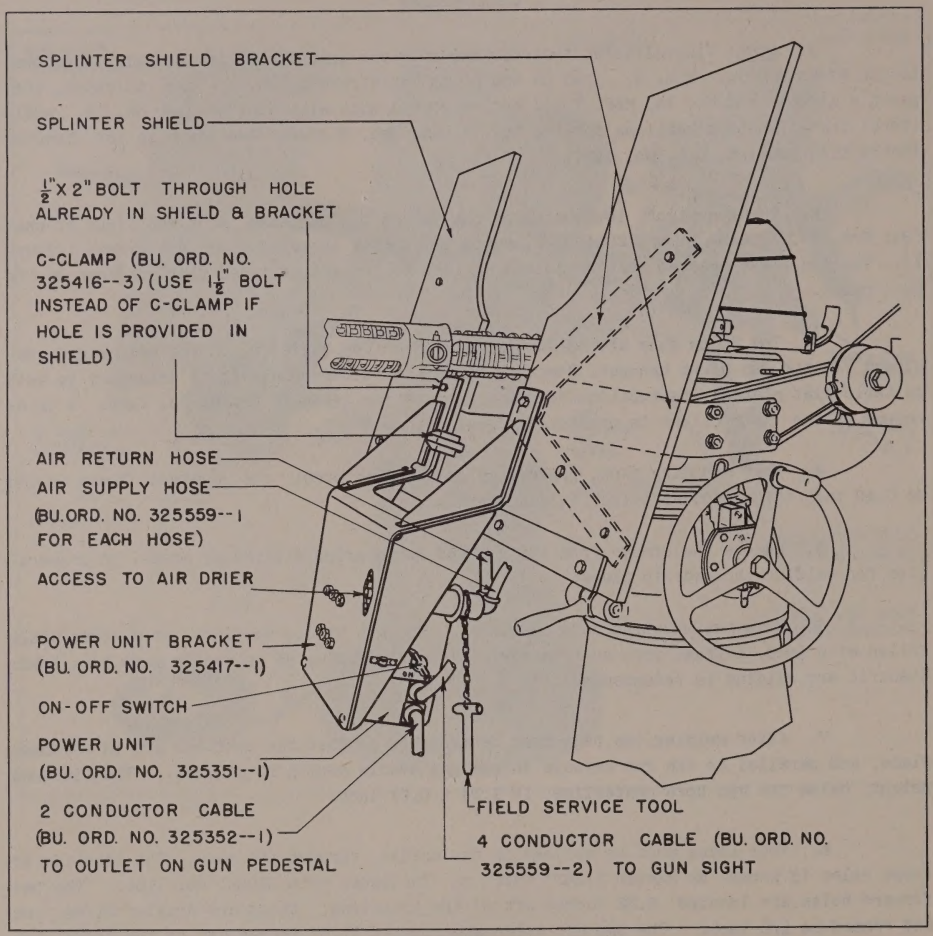

SPLINTER SHIELD BRACKET
SPLINTER SHIELD
½"X 2" BOLT THROUGH HOLE ALREADY IN SHIELD & BRACKET
C-CLAMP (BU. ORD. NO. 325416--3) (USE 1½" BOLT INSTEAD OF C-CLAMP IF HOLE IS PROVIDED IN SHIELD)
AIR RETURN HOSE
AIR SUPPLY HOSE
(BU.ORD. NO. 325559--1 FOR EACH HOSE)
ACCESS TO AIR DRIER
POWER UNIT BRACKET (BU. ORD. NO. 325417--1)
ON-OFF SWITCH
POWER UNIT (BU. ORD. NO. 325351--1)
2 CONDUCTOR CABLE (BU. ORD. NO. 325352--1) TO OUTLET ON GUN PEDESTAL
FIELD SERVICE TOOL
4 CONDUCTOR CABLE (BU. ORD. NO. 325559--2) TO GUN SIGHT

FIGURE 2

POWER UNIT

WITH BRACKET, MOUNTED ON 20 MM GUN

GUNSIGHT BRACKET

10. Mount the gun sight bracket on pads in position shown in figure 1, and secure it with two 1/2 inch bolts in the two aft holes. The bracket then is aligned with the gun barrel, using the boresight tube in the right hand support rod hole of the bracket and the muzzle boresight tool in the gun barrel. The boresight tube (Bu. Ord. No. 325407- -3) has a peep hole at one end and crosswires at the other end. The muzzle boresight tool (Bu. Ord. No. 325520- -1) and the method of installing and checking it is described in the following paragraphs.

11. The muzzle boresight tool consists of a rod which slides into the muzzle of the 20 mm gun, and a small telescope, which is supported by the rod. The rod has near the outer end a cone-shaped bushing which fits snugly in the muzzle, and at the inner end an expansion nut which can be enlarged by turning the knurled knob at the outer end, until it fits tightly inside the barrel.

12. Welded to the rod is a support plate and at the outer edge of the plate is a clamp which holds the telescope parallel to the axis of the rod and thus parallel to the gun barrel. The telescope is a Weaver Type 29-S, having a magnification of 2-1/2 X. It has a set of reference crosswires, with means for shifting their point of intersection.

13. The telescope has an eye relief of approximately 2-1/2 inches. If the eye is placed this distance behind the inner end of the telescope, when sighting through it on a target, the full optical field can be utilized for observing the target.

14. To install the tool, back off the bolt at the outer end of the rod and press the bolt in to release the plunger from the expansion nut. This will allow the rod to be inserted in the gun muzzle. Hold the rod so that the bushing fits snugly against the bore. Then tighten the bolt to lock the tool in position.

15. Each time the tool is used for boresighting, it should be checked for parallelism with the gun barrel. This will insure that the crosswires have not been moved from their correct position since last using the tool. To make this check, place the tool in the gun barrel so that the telescope is directly above the gun barrel and sight through the telescope on a target at least 500 yards distant. Then, holding the barrel steady, rotate the tool 180° around the gun barrel and take another sight. If the crosswires do not stay on target, use the two small adjustment knobs on the telescope to shift the crosswires. Adjustment should be made to correct for one-half the observed error. Then move the gun to bring the crosswires on the target, rotate the tool 180° and check again. Continue adjustment until the crosswires stay on the target for any position of the telescope around the gun muzzle.

16. Having placed the boresight tube and the muzzle boresight tool in position and made proper adjustments, boresight the gun on a target at least 1000 yards distant. Shift the sight bracket until its boresight tube is likewise on the target in train. Boresighting must be true within two mils. NOTE: Two mils is equal approximately to 3 diameters of one crosswire in the boresight tube.

17. Use a C-clamp to hold the forward left side of the gun sight bracket to the gun cradle, and tighten the two aft bolts. Drill the forward right hole in the bracket, applying a 1/2 inch drill up from the underneath through the hole already in the cradle.

Make sure hole is perpendicular to surface of bracket foot. Pass a 1/2 inch bolt through this hole, apply a washer and nut and bring up tight.

18. Remove the C-clamp and similarly drill the forward left hole. Secure with a bolt, washer and nut.

19. Check boresight in train, after the 4 bolts are tightened. Whenever a boresight is taken, the bracket bolts must be tight. If necessary, loosen the 4 bolts slightly, tap the bracket in the required direction to bring it on in train, and again tighten the bolts.

20. Next, boresight the bracket in elevation. If necessary, place shims under the forward or after bracket feet.

21. Because of the rounded shape of the cradle, the right-hand rear bolt is fitted beneath the cradle with a special washer. This washer is furnished with the Gun Sight Mk. 14, Mod. 6 equipment and has a dowel pin to locate it permanently. A #36 drill (0.1065 inch) is run through the washer into the cradle for a total distance of 3/8 inch and is followed with a 7/64 inch drill. The dowel pin then is driven in. NOTE: If desired, rounded surface of cradle may be flattened with an end mill, in which case the special washer can be discarded.

22. When the bracket boresighting is completed, secure each of the 4 nuts, underneath the cradle, with a cotter pin passing through the bolt.

23. Remove the boresight tube from the sight bracket.

GUN SIGHT

24. Remove the gun sight from its carrying case. Remove the support rods from the sight.

25. Place the sight on its bracket, in the position shown in figure 1, so that the holes in the base line up with the holes in the bracket. The support rods then are inserted, and the 4 shock absorber springs and cap nuts are placed as shown. The cap nuts are provided with set screws which must be tightened. The rods are locked in place by tightening the cap screws (see next paragraph) on the bracket. The sight should slide freely (except for the spring restraint) on the rods. If it does not, crocus cloth or fine sandpaper should be used inside the rod holes of the gun sight.

26. The support rods are locked in place by two cap screws in the mounting bracket which engage holes in the rods. Five holes are provided in each rod, to permit fore and aft adjustment of the sight position to suit the individual gunner.

POWER UNIT BRACKET AND POWER UNIT

27. As shown in figure 2, the power (air supply) unit is mounted on a bracket (Bu. Ord. No. 325417- -1) which is suspended from the splinter shield at the front of the gun. Connections to the gun sight are made by means of two rubber hoses, for the air supply, and an electric cable.

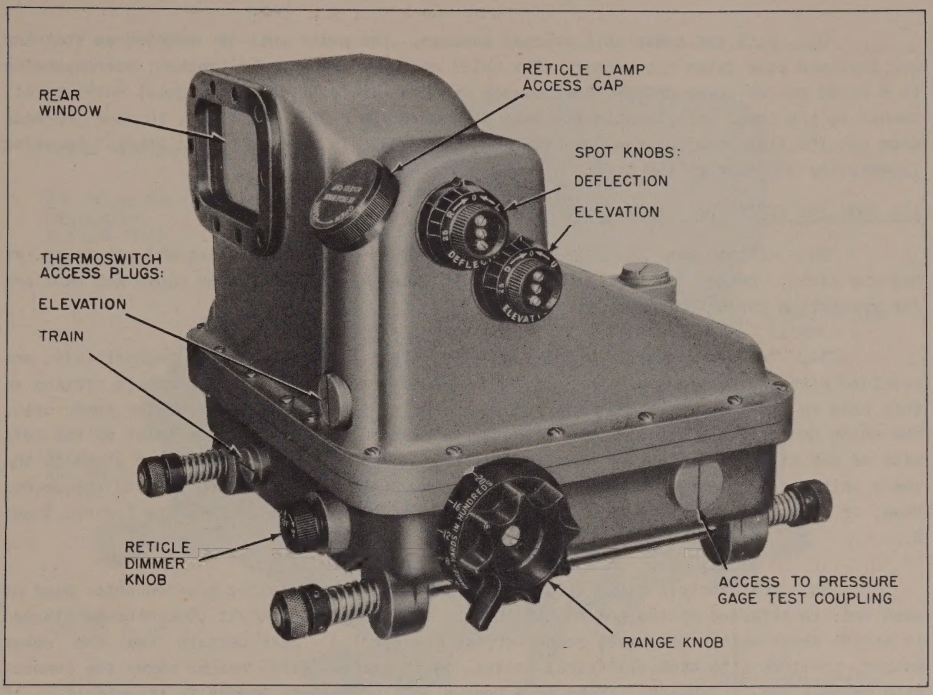


FIGURE 3

GUN SIGHT, RIGHT SIDE SHOWING CONTROLS

THE GUN SIGHT SHOWN HERE IS MK. 14, MOD. 6. THE MOD. 7 AND MOD. 8 SIGHTS APPEAR THE SAME, EXCEPT THAT THE RANGE SCALES ARE GRADUATED TO 2800 AND 3200 YARDS RESPECTIVELY.

28. The bracket is secured by means of 4 bolts, 1/2 inch diameter. The two upper bolts pass through holes which were formerly occupied by two short bolts, serving to fasten the splinter shield to its bracket. After the two short bolts are removed, longer bolts (supplied with the equipment) are used to secure the power unit bracket as well as the splinter shield to the splinter shield bracket, as shown in figure 2.

29. It may be found that the splinter shield permits two possible locations for the power unit bracket. The higher location should be used, provided it does not restrict the maximum depression of the gun.

30. After suspending the power unit bracket as just indicated, use two bolts, 1/2 inch x 1-1/2 inch long, in two lower holes as indicated in figure 2.

31. NOTE: Where the two lower holes are not provided in the splinter shield, it will be necessary to use the pair of C-clamps (Bu. Ord. No. 325416- -3), furnished with the power unit bracket. The screw of each clamp should be at the rear of the shield. The clamps are secured, after tightening, by means of a wire through the head of each clamp screw.

32. With the power unit bracket secured, the power unit is mounted so that the air pressure gage faces the gunner. Six holes will be found in the bracket, corresponding to 6 studs on the power unit. Four spacer washers are provided in a small envelope attached to the power unit, to shim the base at any of the 6 bolt positions, in case the base does not lie flush against the bracket. The power unit is secured on its bracket by using lockwashers and nuts on the studs.

AIR HOSE AND ELECTRICAL CONNECTIONS

33. At the power unit, remove the pipe plugs at the air outlet and air inlet. At the gun sight, remove the pipe caps at the air inlet and outlet. The plugs and caps are for protection during shipment.

34. Two hoses (Bu. Ord. 325559- -1), for air supply and return respectively, are provided with the equipment. One hose has a red mark on each end. The male fitting on this hose is threaded into the outlet (marked red) at the drier cylinder of the power unit; the union on this hose is made up to the elbow (marked red) at the air inlet on the left side of the sight. The second hose is similarly connected to the air inlet elbow at the power unit and the air outlet fitting on the sight. (No red marks are used on the second hose, or on the fittings for this hose at power unit or gun sight.) Refer to figures 1 and 2.

35. The electric cable (Bu. Ord. No. 325559- -2), having a 4-conductor plug at each end, is attached at the power unit and the sight. (The straight connector is plugged in at the power unit; the angle connector, at the sight.) Make certain that the rubber washer, provided with each electrical socket, is in place. This washer makes the connection water-tight. CAUTION: Make sure tongue on plug engages groove in receptacle. If plug is inserted in wrong position, serious damage to electrical circuit may result.

36. As shown in figure 1, the cable and two hoses are supported along their lengths by 3 clamps (Bu. Ord. No. 325418- -1) with grommets (Bu. Ord. No. 325418- -2). The forward clamp, just behind the splinter shield, is fastened through two holes which must be drilled in the splinter shield bracket.

37. The two after clamps are fastened to a cable and hose supporting bracket (Bu. Ord. No. 325560- -1) which is bolted to the splinter shield bracket and the gun mount. The first step is to remove the after pair of bolts which fasten the splinter shield bracket to the left-hand side of the gun mount. Then the same bolts are used to secure the cable and hose supporting bracket, and the splinter shield bracket, to the mount. When this is done, the two clamps, with the hoses and cable, can be mounted on the cable and hose supporting bracket.

38. The cable and hose supporting bracket, and the 3 sets of clamps and grommets, are supplied with the gun sight equipment.

39. A two-conductor cable (Bu. Ord. No. 325352- -1) is plugged into the two-prong receptacle on the power unit, and also into the ship's supply outlet on the gun pedestal, for supplying 115 volt, single-phase, 60 cycle, a-c power to the assembly. Make certain that the rubber washer is in place, when plugging in at the power unit receptacle. As shown in figure 1, this cable is supported by a clamp and grommet on the side of the power unit bracket. The clamp and grommet are supplied with the equipment.

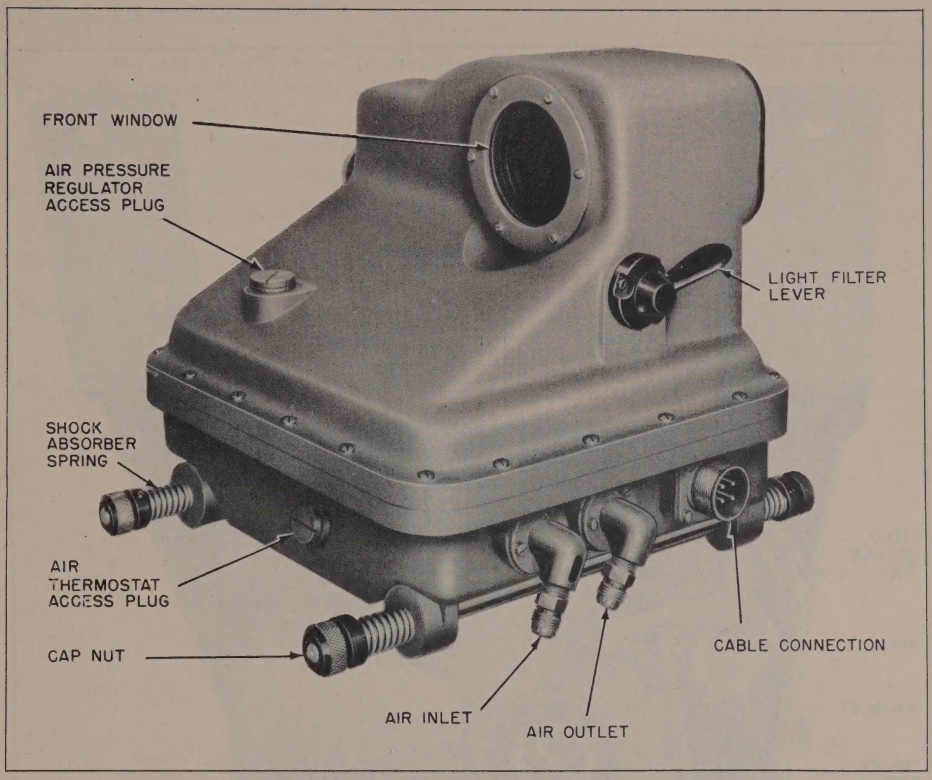


FIGURE 4

GUN SIGHT, LEFT SIDE AND FRONT

PLACING SIGHT IN OPERATION

40. Turn the switch at power unit ON to permit the sight to warm up. A warming up period of two to three hours should be allowed for sights that have been stored, so that the damping fluid may reach an even temperature throughout and attain the viscosity required for smooth operation. For sights used frequently, a warm-up period of 1/2 hour is sufficient. It is important that the sight be kept in approximately horizontal position during the warm-up period and when secured. Lock in 5° elevation if mounted on 20 mm gun, in 0° elevation if on Mk. 51 Director.

41. After the sight has warmed up, check pressure gage on power unit to see that it reads between 6 and 8 lbs. per sq. in. Attach pressure gage to the pressure regulator on sight (see Chapter IV, para. 77 for instructions) and check pressure. The pressure should be from 60 to 62 in. of water, which range lies within the green sector on the gage. Hence, if the pointer is within the green sector the pressure is correct. NOTE: Gages should be checked frequently for accuracy (especially if a number of sights seem to go out of adjustment simultaneously) by comparing them with a standard gage.

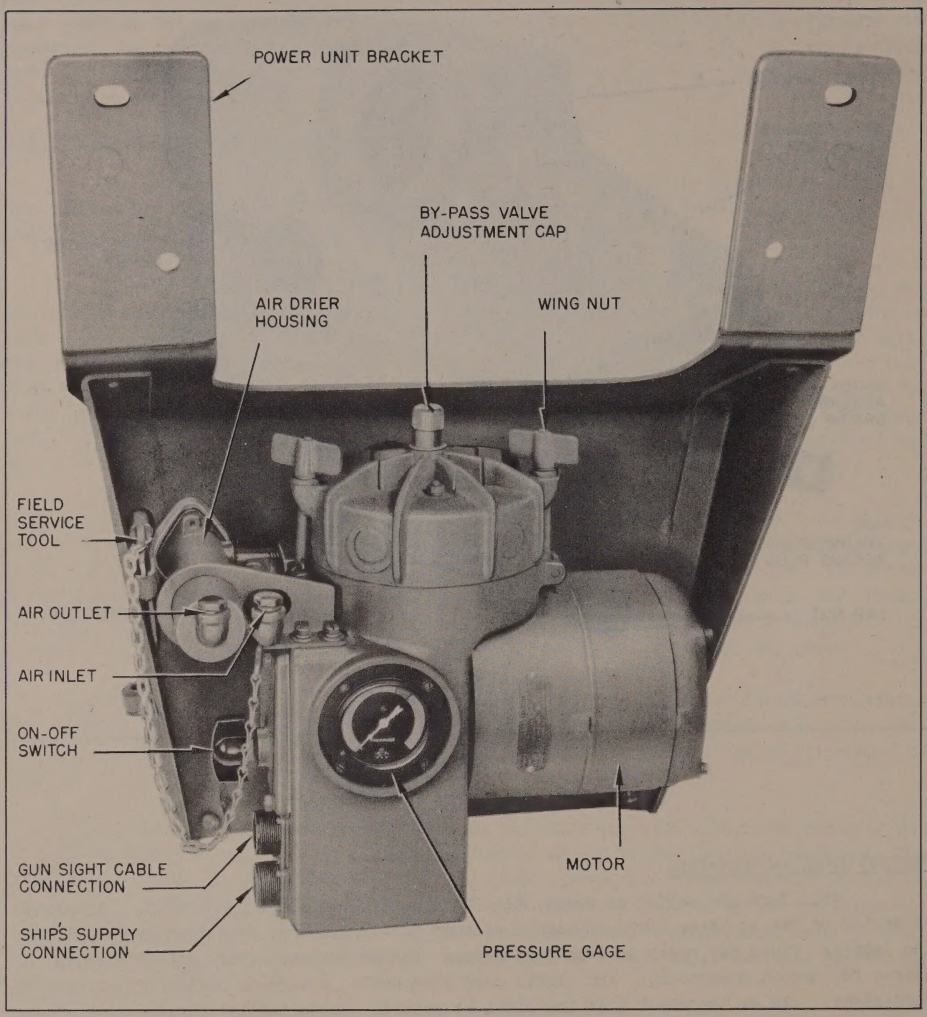


FIGURE 5

POWER UNIT, MOUNTED ON BRACKET

FOR 20 MM GUN INSTALLATION

CHECK ON GUN SIGHT PERFORMANCE

42. After installation is completed the following 3 tests should be made to check on the performance of the gun sight.

(a) The dead zero test

(b) Range shift and superelevation test

(c) Characteristic time test

The procedure to follow is detailed under MAINTENANCE.

BORESIGHTING GUN SIGHT

43. The final step of installation is to boresight the gun sight to its bracket. The procedure is detailed under MAINTENANCE.

CHAPTER III

- OPERATION -

1. NOTES: (a) The procedure given here is intended to supplement the instructions provided with the 20 mm gun. (b) In order to have them ready for immediate use, have gun sights connected and operating continually when guns are manned in war zones.

GUN CREW

2. The gun crew of the 20 mm antiaircraft gun equipped with the gun sight may consist of 4 men:

(a) The gunner, who is strapped against the shoulder rests and aims and fires the gun;

(b) The range setter, who receives or estimates the range data, sets the range pointer and introduces deflection and elevation spots, where necessary, in accordance with doctrines established by forces afloat;

(c) The loader, who changes magazines;

(d) The trunnion operator, who raises and lowers the gun column to maintain as nearly constant as possible the height of the shoulder rest (Mk. 4 and Mk. 6 gun mounts only). NOTE: While the gunner is firing, the trunnion operator should not change the height of the trunnion.

PREPARING FOR ACTION

3. Turn switch at power unit ON. Allow the sight to warm up for 30 minutes, or as long as practicable, before moving it in train or elevation.

4. Observe that pressure gage on power unit reads between 6 and 8 lbs. per sq. in. If gage reads incorrectly, refer to remedies listed on trouble chart in Chapter IV.

5. After sight has warmed up, release train lock and elevation lock pin on gun.

6. CAUTION: Keep gun approximately horizontal until ready to track target. This will allow damping fluid in gun sight mechanism to remain in normal position, and maintain correct operation of sight.

7. Emergency Operation. The sight can be used 10 minutes after being turned on. However, maximum accuracy will be attained only after 30 minutes, when thermal equilibrium will have been established.

ACTION

8. When firing against aerial targets, the procedure employed should be based on doctrines established by forces afloat. Suggested procedures are given in the following paragraphs.

9. Adjusting Reticle Brightness. Set the reticle dimmer knob (figure 3) so that the reticle within the sight is plainly visible against the brightest portion of the sky but not so bright as to obscure the target. Swing filter into place if necessary. CAUTION: To prevent overheating the gun sight and to prolong life of lamp, turn the reticle dimmer knob to OFF position whenever the sight is not in active use.

10. Picking Up the Target. Set range knob at 400 yards, to restrict the reticle movement when the gun is swung rapidly.

11. As the target is picked up in the window, bring the reticle on the target and establish a smooth tracking rate as soon as possible. As soon as the gunner is on target, he gives the "on target", or other suitable signal, to inform the range setter. The range setter then turns the range knob smoothly to the desired range for opening fire. It is essential that the range knob be turned smoothly in order not to throw the gunner off the target.

Tracking

12. Smooth, accurate tracking is the most important factor in obtaining hits when using the Mk. 14 Sight. This is because the solution computed by the sight is directly dependent upon the tracking rate established by the gunner. If the tracking is inaccurate; i.e. the gunner does not keep the reticle centered on the target, the lead computed by the sight will not be correct. Likewise, if the tracking rate is uneven; i.e. the gunner fails to move the sight with a smooth, steady tracking motion, the lead computed by the sight will not be steady or correct.

13. Due to the damping effect, it is also necessary that the gunner track the target long enough to permit the sight to establish the correct lead. Normally, a second or two of smooth tracking is sufficient.

14. Trunnion Operation. The gunner and trunnion operator must be a well co-ordinated team if smooth tracking is to be accomplished. It is recommended that the column be raised as high as the gunner can comfortably stand when tracking begins and, when smooth tracking is established, the trunnion operator uses the greatest care in moving the hand wheel. When the gunner has commenced firing, the trunnion operator should not change the height of the trunnion.

15. Firing. Inexperienced gunners using the Mk. 14 Sight on the 20 mm gun, usually have difficulty in keeping the target in view. This is to be expected, since a little training is required to become familiar with the sight. For his first firing runs, the gunner should remember the following points:

(a) Keep the reticle dimmed so that it can be seen comfortably. If it is too bright, it may obscure the target.

(b) Concentrate most on seeing the target, less on watching the reticle. With practice at tracking, the gunner will learn more readily to keep the reticle on the target.

(c) Avoid keeping the head in a fixed position behind the sight. It is necessary to move the head slightly in order to keep the reticle in view when tracking.

(d) Fire in short bursts at first. Check firing momentarily when target is lost or obscured by smoke. Resume firing as soon as target is picked up and reticle is correctly centered on it. As the gunner gains experience and becomes accustomed to the gun and sight, he will be able to fire longer bursts until, finally, he can maintain continuous fire and keep the reticle centered on the target.

Range Setting

16. Smooth range setting is another factor of great importance in helping the gunner to track smoothly. The range setter must avoid making abrupt range changes. Any change of range during tracking or firing must be made with a smooth movement of the range knob.

17. In general the procedure of range setting consists of, either using a fixed doctrine range setting into which the plane must fly, or setting an initial range based on estimation and then, making one or two range corrections, using the tracer stream as a guide. The latter requires that the range setter must understand tracer observation and follow a definite procedure, which will depend on the approach angle of the target.

18. Approaching Target. In the latter method, if the tracers appear to pass ahead of the target, the range set in the sight is too great. The range setter then should decrease the range setting by 400 or 800 yards. The tracers then will be observed to pass, first behind, then through and finally ahead of the target, upon which the range setting again is decreased.

19. CAUTION: Decreasing the range too soon results in the fire being continually below and behind the target. Hence, it is important that the tracers appear to pass ahead of the target before the range is decreased.

20. It should be remembered that gun dispersion, average tracking error and target size all are factors which determine the effectiveness of fire. Because of these factors, the hitting range of the gun may extend several hundred yards above and below the range set in the sight.

21. NOTE: On installations on the 20 mm gun, the operational procedure must take into consideration the limitations of the gun. Because of the short effective range of the gun, a fixed range setting of 800 or 1200 yards is generally used for all approaching targets.

22. Outgoing Target. Tracking and firing on an outgoing target is accomplished in a manner similar to that for an approaching target, except that the range knob is set to an initial value greater than the actual range. As the target goes out, the range is increased each time the tracer stream appears to pass under and behind the target.

23. Spotting. The spot knobs are for the purpose of making small corrections for ballistic and boresight errors. Generally, if the gunner tracks smoothly and the range is set properly, spotting corrections will not be necessary. The normal dispersion of a well boresighted gun will produce hits for all except very unusual conditions. Therefore, for most effective fire, using the Mk. 14 sight, the range setter should concentrate on proper range setting.

24. The range setter should avoid making spotting corrections during firing. He should make spot corrections only when the gunner is tracking accurately and a clear observation of the tracers shows an error to exist. IF THERE IS ANY DOUBT AS TO THE CORRECTIONS TO BE APPLIED, NO SPOT SHOULD BE MADE. Spot knob should be rotated in the direction toward which movement of tracer stream is desired, that is, if the tracer stream is seen below the target, spot "UP", if seen above, spot "DOWN". Likewise, if it is required to bring the tracers to the right, spot "RIGHT", if to the left, spot "LEFT".

SECURING GUN

25. When securing the gun, it is important that the gun sight mounted on it be left in an approximately horizontal position. This will allow the damping fluid used in the mechanism to settle properly. If the damping fluid were to settle in an incorrect position, the characteristic time and the general operation would be faulty when the gun sight is put in operation again. If, inadvertently, the sight is left in a near vertical position, proceed as follows: Place sight in horizontal position, warm up for 2 to 3 hours and check performance of sight by making the dead zero, range shift and characteristic time tests as detailed under MAINTENANCE.

26. When securing gun, observe following instructions:

27. Shift range knob to maximum range.

28. Bring gun to mid position in train, and lock. Bring gun to 5° elevation, and insert lock pin. (The 5° elevation point is determined by moving gun slowly at a low elevation until lock pin slides into place.)

29. Turn switch at power unit OFF.

NOTES

30. The gun sight is designed to have maximum accuracy when used against approaching targets. That is, the range scale on the sight, and the superelevation correction introduced at each range setting have been calculated on the basis of typical approaching target courses and speeds. The range scale design assures that the required lead angle for an approaching target is generated at each range setting.

31. When the gun sight is slewed rapidly to pick up a target, a large lead angle is generated because of the high angular velocity used. Smooth tracking will be established at some lower angular velocity, but the reticle will not immediately indicate the correct (smaller) lead angle, because of the effect of the smoothing (damping) action in the sight. It will be observed that the time required for the reticle to move from the position it assumes during slewing to the correct position under smooth tracking conditions will vary with the range setting. This time will be smallest at the shortest range setting, and largest at the maximum range setting. Therefore, keep the range at 400 yards when slewing.

32. In order to reduce the time required to establish the correct lead angle, after slewing the sight to pick up a target, the "overshooting" procedure is recommended. This is simply to swing the reticle image slightly beyond and then back onto the target thus permitting the reticle to settle more promptly.

33. When "overshooting" the target, the reticle should be kept in view and slewing should be continued until the reticle has passed the target by a moderate amount. Then the direction of slewing should be reversed and the reticle brought immediately on the target. At this stage, the operator should establish smooth tracking as quickly as possible, and the range handle should be shifted smoothly but quickly from the 400-yard setting to the required value for opening fire.

34. The 20 mm gun on which Gun Sight Mk. 14, Mod. 6 is mounted can be swung freely in train and elevation. The movement in train is limited only by the 20-foot cable which carries the electrical supply to the power unit; this cable should not be wound more than once around the pedestal.

TRAINING

35. Checksight. The checksight is intended to serve as an aid in training gunners. It enables an instructor to observe the reticle and target as the gunner is tracking and thus determine if tracking is smooth and accurate. It is important that gunners be given frequent tracking drills and adequate instructions on how to track correctly.

36. On the 20 mm antiaircraft gun, the use of the checksight is largely restricted to instruction on non-firing runs. However, when using the gun sight on Gun Director Mk. 51, it is possible to observe tracking during a firing run, and the checksight can be used to great advantage during all firing practices.

37. Since smooth tracking is of major importance in obtaining good results using the Mk. 14 sight, gunners and director operators should practice tracking on real targets as much as possible. However, when real targets are not available, the lens and scale fixture (Bishop's Hat) can be used for tracking practice as described in the following paragraphs.

38. Mount fixture on sight as described in Chapter IV, paragraphs 16 and 17. The dots shown on the universal scale (figure 8) are used as targets for tracking practice. The gunner then moves the gun or director at the correct rate in train and elevation, or both, to keep the reticle accurately centered on the dot selected for tracking.

39. The dots represent different lead angles or, in other words, targets at various ranges, coming in at various approach angles.

40. It is recommended that gunners and trunnion operators have tracking drills regularly while at sea, using the lens and scale fixture. This will enable them to develop the muscular coordination and familiarity with the sight and gun which is necessary to track smoothly on board a rolling and pitching ship. The tracking problem may be made more difficult, hence, more interesting, by changing the range setting as the gunner tracks. The checksight permits the instructor to observe the tracking and teach the gunner during tracking practice.

CHAPTER IV

- MAINTENANCE -

GUN SIGHT

1. The maintenance instructions given here apply equally to the gun sights and power units mounted on the 20 mm gun, and to those mounted on Gun Director Mk. 51. In the latter case, simply substitute "director" in place of "gun", when following the instructions.

2. It is recommended that vessels, having a number of gun sights, have at least two experienced men detailed to the upkeep of the sights. CAUTION: Except as outlined in paragraphs 72 to 106 and in the "Trouble Chart" of this Chapter, any adjustment or repair of the gun sight that may become necessary should be done only by suitably trained personnel at qualified repair stations.

DAILY CHECKS

Daily, or Whenever Sight Is In Use

3. Turn on power and warm up sight for 30 minutes.

4. Check air pressure gage on power unit. It should read between 6 and 8 lb. per sq. in.

5. Set both spot knobs on zero detent.

6. Turn reticle dimmer knob first to one and then to the other "BR" position while observing the reticle. In each case, the reticle should come up to maximum brightness. If not, inspect reticle lamp and replace if necessary. Then set knob to give desired illumination of reticle.

7. Check reticle movement. Set range knob at maximum range. Swing sight to one side in train until reticle is seen to hit the stop, then hold the sight stationary and observe the reticle return to its central position. The reticle movement must be smooth and steady. Repeat the test for the other direction in train and both directions in elevation. If reticle movement appears jerky or irregular in any of these checks, the sight must be adjusted at a gunsight repair base.

8. If the preceding checks are satisfied, the sight is ready for operation. Set range handle at 400 yards, the standby position.

PERIODIC TESTS

9. Sight air pressure regulator. Check air pressure at least every two weeks, or for every two hundred hours of operation, whether at sea or in port. See paragraph 77, in this Chapter for procedure employed in checking pressure. NOTE: It is recommended that the sight air pressure be checked whenever sight has been subjected to shocks, due to firing large caliber guns or other causes.

PERFORMANCE TESTS

10. NOTE: It is recommended that the tests listed below be made every two weeks or for every 200 hours of operation. However, it is essential that the vessel be in calm water, preferably tied up to a dock or at anchor, and that no appreciable pitching movement is imparted to it. All performance tests must be made with the gun pointing forward or aft, parallel with centerline of ship, or as close thereto as possible. The sight must have been turned ON for at least 1/2 hour so as to be thoroughly warmed up, before tests begin.

11. Following are the performance tests and the order in which they should be made.

(a) Dead zero test (para. 20).

(b) Range shift and superelevation test (para. 32).

(c) Characteristic time test (para. 47).

(d) Check boresight of gun sight (para. 54).

THE UNIVERSAL SCALE

12. Dead zero, range shift and characteristic time tests are made with the aid of the universal scale shown in figure 8. The scale comprises a shallow dish with graduations on the concave side. It is designed for use with the lens and scale fixture (also known as the "Bishop's Hat"). A description of the scale and the method of mounting the fixture on the sight follows.

13. Scale Center. The intersection of the vertical and horizontal centerlines is defined as the scale zero. Beginning at scale zero, the scale is marked off with 5 and 10 mil graduations in 4 directions: up, down, left and right up to 90 mils in each direction. Intermediate values in the neighborhood of 5 and 10 mils must be estimated.

14. Dots. The black dots, seen extending radially from the center of the scale, are used for training. Method of using them is described in Chapter III, para. 38.

15. Characteristic Time Marks. In each of the 4 directions is a mark at 210 mils and another at 78 mils, for use when measuring characteristic time.

16. Mounting the Lens and Scale Fixture, Mod. 6 Sight. (See figure 7.) Remove cap nut and shock absorber spring from the front end of each gun sight supporting rod. Mount the fixture on the supporting rods so that the fixture lens is in front of the sight window as shown in figure 7. Take up on the clamp nuts until both shock absorber springs, at the rear end of the supporting rods, are compressed completely.

17. Mounting the Lens and Scale Fixture, Mod. 7 and 8 Sights, on Mk. 51 Director. Remove cap nuts and spacers from both ends of the two gun sight supporting rods. Place a clamping bushing (two are provided with the lens and scale fixture and shown in figure 7) on the rear end of each supporting rod and replace the rear cap nuts. Then mount the fixture on the front end of the support rods and take up on both clamp nuts until they are tight.

18. Adjusting Universal Scale to Apparent Zero. Turn range knob to median range and set spot knobs to zero. Adjust reticle dimmer knob so that the reticle center dot is plainly visible. With reticle in its central position, sight through the sight window and observe position of reticle center dot with reference to the scale. If the dot is not on scale zero loosen clamp screw (figure 7) and move scale dish until the center dot appears to be approximately on scale zero and one of the centerlines appears to be level. Then tighten the clamp screw.

19. To check if horizontal centerline is level, first lock gun in 5° elevation (51 Director in zero elevation) then swing the sight in train and observe reticle center dot as it travels along the scale centerline. If the path of the center dot is parallel to the centerline, the line is level. If centerline is not level, loosen clamp screw, turn scale in the required direction, tighten clamp screw and repeat check. When scale centerline is level, spot the reticle center dot on scale zero.

DEAD ZERO TEST

20. Purpose. The purpose of this test is to determine the width and height of the dead zero area, and to set the reticle at the center of this area. The dead zero area is that area in any part of which the reticle may settle, when moving from any direction.

21. Procedure. Have gun sight in horizontal position and set range knob at maximum range.

22. Swing sight to left in train so as to generate maximum lead angle on right side of scale. Bring sight to rest and allow one minute for reticle to settle taking care to keep sight motionless. Using deflection knob, spot reticle to zero (vertical centerline on scale).

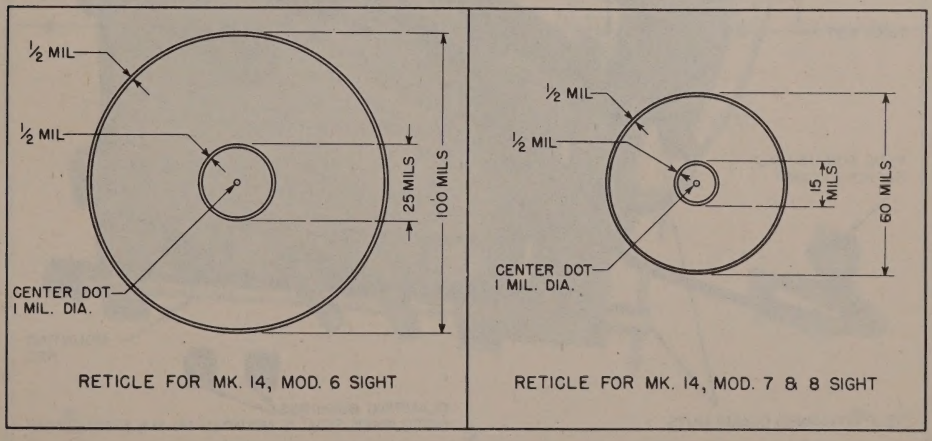


FIGURE 6
GUN SIGHT RETICLE

23. Swing sight to right, generating maximum lead angle on left side of scale. Let reticle settle for one minute and record scale reading. This reading is the width of the dead zero area.

24. Using deflection knob, spot reticle to middle of area just determined. For example, if reticle settled 4 mils to the left of scale zero, spot the reticle so that it is two mils to the left of scale zero.

25. Lock gun or Director in train, to make dead zero test in elevation.

26. Elevate sight, return it rapidly to horizontal and lock in that position (5° elevation for 20 mm gun, 0° elevation for Mk. 51 Director).

27. Allow one minute for reticle to settle (it will be seen moving down on scale). Using elevation knob, spot reticle center dot to zero (horizontal centerline on scale).

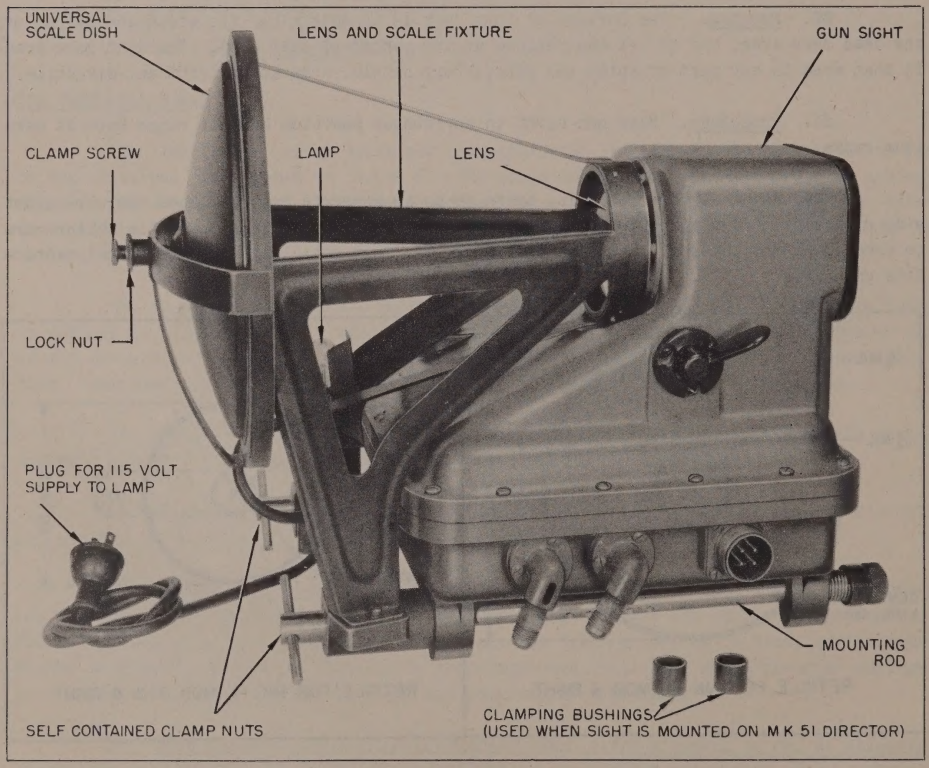


FIGURE 7

LENS AND SCALE FIXTURE (BISHOP'S HAT)

MOUNTED ON MOD. 6 GUN SIGHT

28. Depress sight as far as it will go, return it rapidly to horizontal and lock in that position.

29. Allow one minute for reticle to settle (it will be seen moving up on scale) and observe scale reading. This reading is the height of the dead zero area.

30. Using elevation knob, spot to the middle of the area just determined.

31. If the dead zero area, as just determined exceeds 7 mils in train or elevation, the sight must be adjusted at a gun sight repair station.

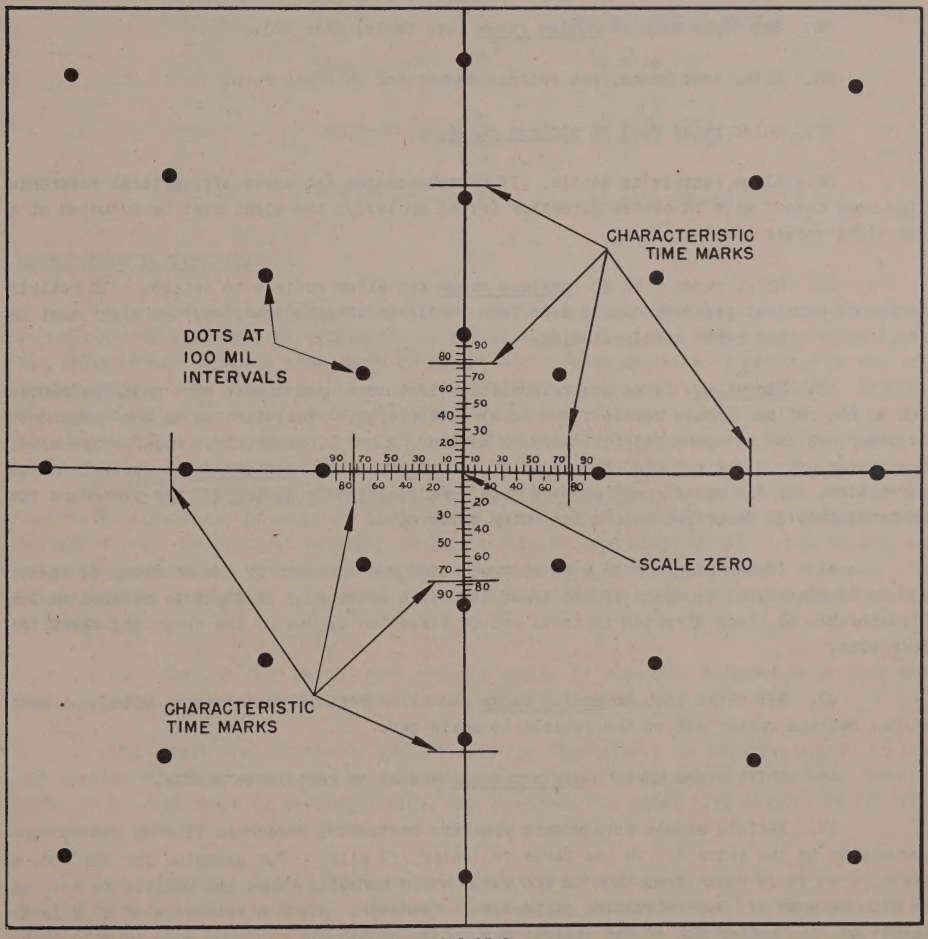


FIGURE 8
UNIVERSAL SCALE

RANGE SHIFT AND SUPERELEVATION TEST

32. This test follows immediately after the dead zero test and with the lens and scale fixture adjusted as described for that test.

33. Train. When the gun sight is stationary, the center dot of the reticle should remain fixed in train, within small limits, as the range knob is moved.

34. Lock gun in train, by use of clamp on mount, and at 5° elevation by use of the lower elevation lock pin setting. If sight is mounted on Gun Director Mk. 51, lock director in train and 0° elevation by use of the train and elevation lock pins.

35. Set range knob to median range (see table, page 31).

36. Using spot knobs, set reticle center dot on scale zero.

37. Shift range knob to minimum range.

38. Allow reticle to settle. If reticle center dot moved off vertical reference line more than 7 mils in either direction (right or left), the sight must be adjusted at a gun sight repair station.

39. Shift range knob to maximum range and allow reticle to settle. If reticle moved off vertical reference scale more than 7 mils in either direction, the sight must be adjusted at a gun sight repair station.

40. Elevation. If no superelevation weight were used on each gyro unit, the center dot of the reticle should remain fixed in elevation, within small limits, as the range knob is moved, while the sight is stationary. However, since superelevation weights are used, the center dot of the reticle should shift according to the difference in superelevation correction, as the range knob is moved from one position to another. The procedure for checking this is described in the following paragraphs.

41. If the sight is on a 20 mm gun, lock gun in train by use of clamp on mount, and in 5° elevation by means of the lower lock pin setting. If sight is mounted on Gun Director Mk. 51, lock director in train and 0° elevation by use of the train and elevation lock pins.

42. Set range knob to median range and allow reticle to settle. Using the spot knobs, set the center dot of the reticle to scale zero.

43. Shift range knob to minimum range and allow reticle to settle.

44. Reticle should move upward from the horizontal reference line an amount corresponding to the value A, in the table following, ±7 mils. For example, for the Mod. 6 sight, a shift in range from 1200 to 400 yards would normally cause the reticle to move up 12 mils because of superelevation correction. However, since a tolerance of ±7 mils is permitted, the center dot of the reticle may settle within the range of 5 to 19 mils above the horizontal. If the reticle settles outside of this range, the sight must be adjusted at a gun sight repair station.

45. Shift range knob to maximum range and allow reticle to settle.

46. Here the reticle should move downward from the horizontal reference line an amount corresponding to the value B, in the table, ±7 mils. If the reticle center dot does not settle within this range the sight must be adjusted at a gun sight repair station.

SUPERELEVATION TABLE

Movement of Reticle as Range Knob is Moved

Gun Sight Mark 14	Range in Yards: Median Value	Range in Yards: Shift To	Reticle Should Move	
Mod. 6	1200	400	12 mils (up)	A
		2000	18 mils (down)	B
Mod. 7	1600	400	12 mils (up)	A
		2800	15 mils (down)	B
Mod. 8	2000	400	12 mils (up)	A
		3200	12 mils (down)	B

CHARACTERISTIC TIME TEST

47. Characteristic time is defined as that time interval required for the reticle to return from some initial deflection to 37% of that deflection. This is provided for by two lines (characteristic time marks in figure 8) in each of the 4 directions on the universal scale. The outer line represents 210 mils deflection, the inner line, 78 mils. Thus the outer line is used for the initial deflection, and the inner line for 37% of that deflection. The scale zero is the point of reference for all characteristic time marks.

48. To check characteristic time of the train gyro. If sight is on a 20 mm gun lock in 5° elevation, if on a Mk. 51 Director lock in zero elevation and set range knob at maximum value. Swing sight to right through an arc of approximately 45°, stop quickly and keep sight motionless (swing only rapidly enough to deflect reticle to end of scale; too rapid swinging may damage gyro unit). Reticle will be seen moving to right from left end of scale.

49. Start a stop watch when reticle center is observed to pass outer (210 mil) mark, and stop the watch when inner (78 mil) mark is reached.

50. Check characteristic time in reverse direction, by swinging sight to left and timing reticle movement. Continue to take readings in alternate directions until a total of 10 readings, 5 in each direction, are obtained. The total time divided by 10 gives an average time which should minimize any personal error.

51. Caution: If it is found that the 10 observations in any run differ from one another by 0.4 second or more, the figures should be discarded and, after checking the setup, a new run made. It is essential that the sight remain steady while observations are being made.

52. To check characteristic time of the elevation gyro, first lock gun in zero train and set range knob at maximum value. Depress sight as far as possible and allow reticle to settle. Then return sight rapidly to horizontal and time the reticle movement as before described. The sight must be horizontal and motionless while reticle is being timed. Next, elevate sight about 60°, allow reticle to settle, return sight to horizontal and time the reticle movement. As with the train measurements, take the average of 10 readings, 5 in each direction.

53. The characteristic time should be within the limits shown in the table following:

Gun Sight	Range Setting	Characteristic Time, Seconds			
		Room Temp. (65°-85°F)		Extreme Temp. (0° or 100°F)	
Mk. 14 Mod.	Yards	Min.	Max.	Min.	Max.
6	2000	5.8	6.3	5.3	6.7
7	2800	6.4	6.9	5.9	7.4
8	3200	6.4	6.9	5.9	7.4

The characteristic time values should fall within the limits given for room temperature conditions, when the sight is being checked in a service station, or on board ship if the temperature is within 65°-85° F. However, if the sight is checked when the surrounding atmosphere is below 65° or above 85° F, wider tolerances must be allowed. The permissible tolerances for extreme temperature (0° or 100° F) are given in the list.

BORESIGHTING THE GUN SIGHT

54. Connect power cable to the 115-volt, 60 cycle, a-c ship's supply and allow sight to warm up for at least 1/2 hour. NOTE: A warming up period of two to three hours is recommended for replacement sights, particularly if sight has been stored some time before installation.

55. Select a target approximately 1000 yards distant and situated so that the boresight can be made with the gun pointing approximately forward or aft.

Cycling

56. Cycling is a process for settling the reticle on its true zero position. It should be employed always in advance of boresighting. Since the process eliminates any "dead zero" effect, it improves the accuracy of the boresight.

57. Using the target selected, the sight is cycled in both train and elevation in such a manner as to bring the reticle to bear on the target.

58. Cycling is accomplished as follows:

(a) Set range knob at maximum range.

(b) Train. Holding sight approximately horizontal, bring the reticle to bear on the target. Swing sight rapidly, first to one side and then to the other, observing the reticle while swinging, to see that it strikes the stop in each direction. Then swing the sight so that the reticle moves through successively smaller arcs on each side, finally letting it come to rest at the mean position, and aiming it approximately at the boresight target.

(c) Elevation. Holding sight approximately on target, swing sight rapidly up and then down, observing the reticle while swinging, to see that it strikes the stop in each direction. Then swing sight so that the reticle moves through successively smaller arcs on each side, finally letting it come to rest at the mean position, aiming it at the boresight target.

Boresighting

59. The gun sight should be boresighted every two weeks as already prescribed, as a check. Whenever a gun sight is replaced, this procedure must be carried out. During the procedure, the sight must be kept steady to enable the reticle to settle to its central position. Two men are required, one to sight the target through the sight window and one through the boresight tube.

60. Place boresight tube (Bu. Ord. No. 325407- -3) in right-hand support rod hole of gun sight bracket and gun sight. Sight through tube on a target at least 1000 yards distant.

61. Set reticle dimmer knob (figure 3) so that center dot is plainly visible.

62. Set range knob to median range. Median ranges for Mk. 14, Mod. 6, 7 and 8 gun sights are listed in the following table.

Gun Sight Mk. 14, Mod.	For Use With Gun	Set Range Knob at Median Range Listed (Yds.)
6	20 mm	1200
7	1.1 inch	1600
8	40 mm	2000

63. Set deflection spot knob on zero detent. To do this, set the white graduation near the red "0" on the knob, to the index.

64. Set elevation spot knob so that index coincides with the third detent from zero on the "DOWN" scale. This detent is identified on the knob by the white graduation adjacent to the red "D". This operation shifts the reticle 15 mils in elevation (detent positions of spot knob are spaced 5 mils apart), which is the superelevation correction for the median range.

65. Observe target through sight window and boresight tube. The sight is boresighted correctly if the center dot of the reticle (figure 6) is centered on the same target as the crosswires of the boresight tube, the two sights being taken simultaneously. NOTE: If possible, check the gun boresight against the boresight tube, before checking reticle against boresight tube.

66. If setting is incorrect, turn both spot knobs until center dot (figure 6) is centered on target. Remove the center screw, holding the elevation spot knob with its bushing to the corrugated shaft, pull knob and bushing clear of shaft and turn the knob until the 15 mil mark on "DOWN" scale coincides as nearly as possible with index mark (arrow). Push knob and bushing back on shaft and make final adjustment. To do this loosen the two outside screws and turn the knob only until the index is exactly on the 15 mil mark. Tighten the two outside screws, replace and tighten the center screw. To adjust the deflection spot knob proceed in a manner similar to that just described for the elevation spot knob, except that for the deflection spot knob, the index must coincide with the zero mark on the knob. After adjustments have been made check boresight. Set elevation spot knob to zero and remove boresight tube.

67. When checking a large number of sights, it may be found easier to check the boresight directly between the gun barrel and the reticle, using the muzzle boresight tool (Bu. Ord. No. 325520- -1). The procedure, using this method, is described in the following paragraphs.

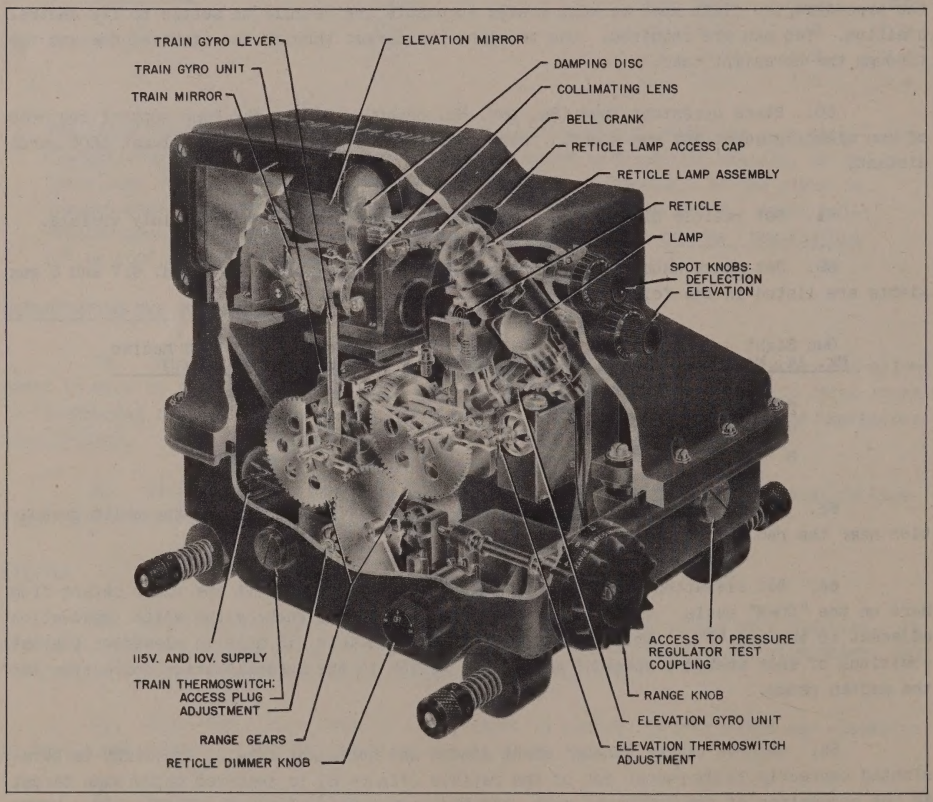


FIGURE 9

GUN SIGHT-REAR VIEW, SHOWING MECHANISM

68. First check the muzzle boresight tool for parallelism as described in Chapter II, paragraphs 14 and 15. Place muzzle boresight tool in the gun barrel and bring crosswires of scope on a target at least 1000 yards distant.

69. Set range knob to median range. Set deflection spot knob to zero and elevation spot knob to white graduation adjacent to the red "D".

70. Allow reticle to settle in rest position and check boresight. If the reticle center dot is on the same target as the crosswire in the scope, the boresight is correct. If reticle center dot is not on target, make corrections as described in para. 66 above. After adjustments have been made, set elevation spot knob to zero and remove boresight tool.

71. If the characteristic time in train is not within the limits given, the train gyro unit thermoswitch must be adjusted. If the characteristic time in elevation is not within the required limits, the elevation gyro unit thermoswitch must be adjusted.

THERMOSWITCH ADJUSTMENT

72. Should it be necessary to adjust a gyro unit thermoswitch, proceed as follows: Remove the access plug at the rear of the sight (figure 3). The plug for the train gyro is at the left; that for the elevation gyro, at the right. A small pencil-type flashlight can be directed into the access opening, to illuminate the adjusting shaft.

73. The adjusting shafts are shown in figure 9, the shaft for the train gyro at the left, that for the elevation gyro at the right. If characteristic time is too short, the adjusting shaft must be turned clockwise. This will cause the thermoswitch to maintain a lower temperature. Conversely, if characteristic time is too long, the adjusting shaft must be turned counterclockwise to establish a higher temperature.

74. Adjustment is made using the thermoswitch adjustment wrench provided for each ship. In using the wrench, care should be taken not to mar the range gears. It is best to turn the adjusting shaft in small steps, say 1/8 turn.

75. When the thermoswitch setting has been completed, replace access plug and allow sight to warm up for 10 minutes, to restore thermal equilibrium, before taking new readings of characteristic time.

76. Air Thermostat. The setting of the air thermostat can vary somewhat without appreciably affecting the general operation. Consequently, there should be no occasion to adjust this thermostat.

AIR PRESSURE REGULATOR ADJUSTMENT

77. To check the air pressure, attach a portable pressure gage, which must be known to be correct, (Chapter II, para. 41) to the air pressure regulator test coupling. Access to this coupling is had by removing the plug (figure 3), located near the range knob.

78. Correct pressure is indicated when the pointer is within the green sector on the scale.

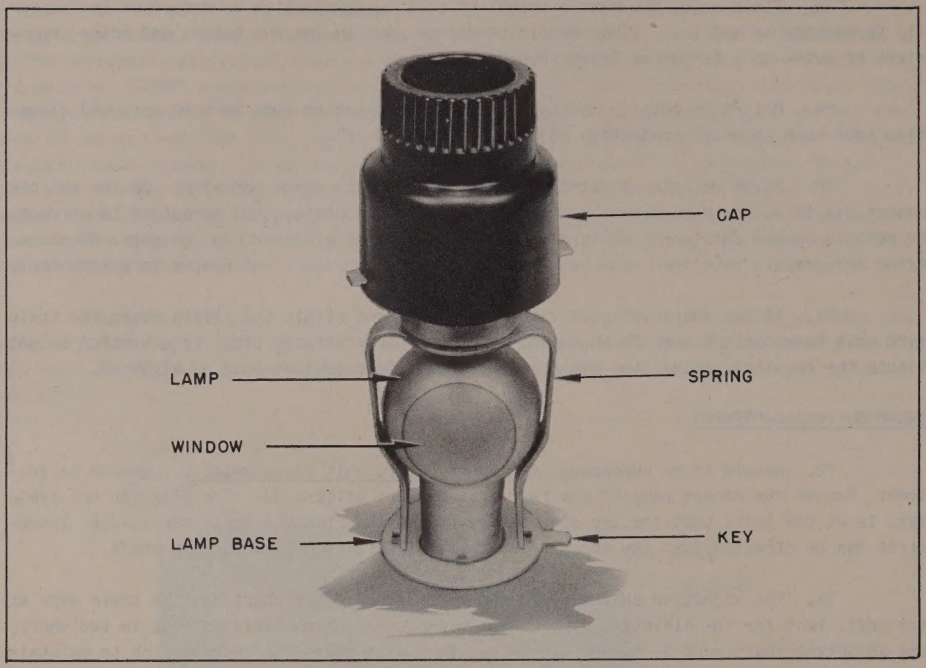


FIGURE 10

RETICLE LAMP SPRING AND CAP ASSEMBLY

A RETAINING SPRING (NOT SEEN IN THE FIGURE) IS PROVIDED IN THE LAMP BASE TO HOLD THE LAMP SECURELY IN PLACE.

79. If pointer shows incorrect pressure, check the gage on the power unit. If reading here is between 6 and 8 lb. per sq. in., check hoses, hose connections, pump air drier and sight air filter. If no leak or restriction is found, then adjust air pressure regulator.

80. To reset regulator, proceed as follows: Remove access plug (figure 4). Loosen hexagonal locknut at top of regulator (figure 10). If air pressure is low, turn adjustment screw clockwise; if pressure is high, turn screw counterclockwise. Tighten locknut. Replace access plug, making sure gasket is set up airtight.

CLEANING AIR FILTER

81. Once a month the air filter should be cleaned. The procedure follows.

82. Remove the 3 screws securing the air inlet elbow (figure 4). Remove the elbow, take out the wire mesh filter and remove accumulated dirt and dust. Replace filter and air inlet elbow, making sure the gasket is set up airtight.

REPLACING RETICLE LAMP

83. First remove reticle lamp access cap (figure 3) to expose the reticle lamp spring and cap assembly. To replace the lamp it is necessary to remove this assembly from its housing. The assembly is shown in figure 10. Push down on assembly cap, then turn it counterclockwise as far as it will go and lift out the assembly from the housing.

84. Next remove the reticle lamp from its base by pushing the lamp down against the retaining spring and turning it counterclockwise.

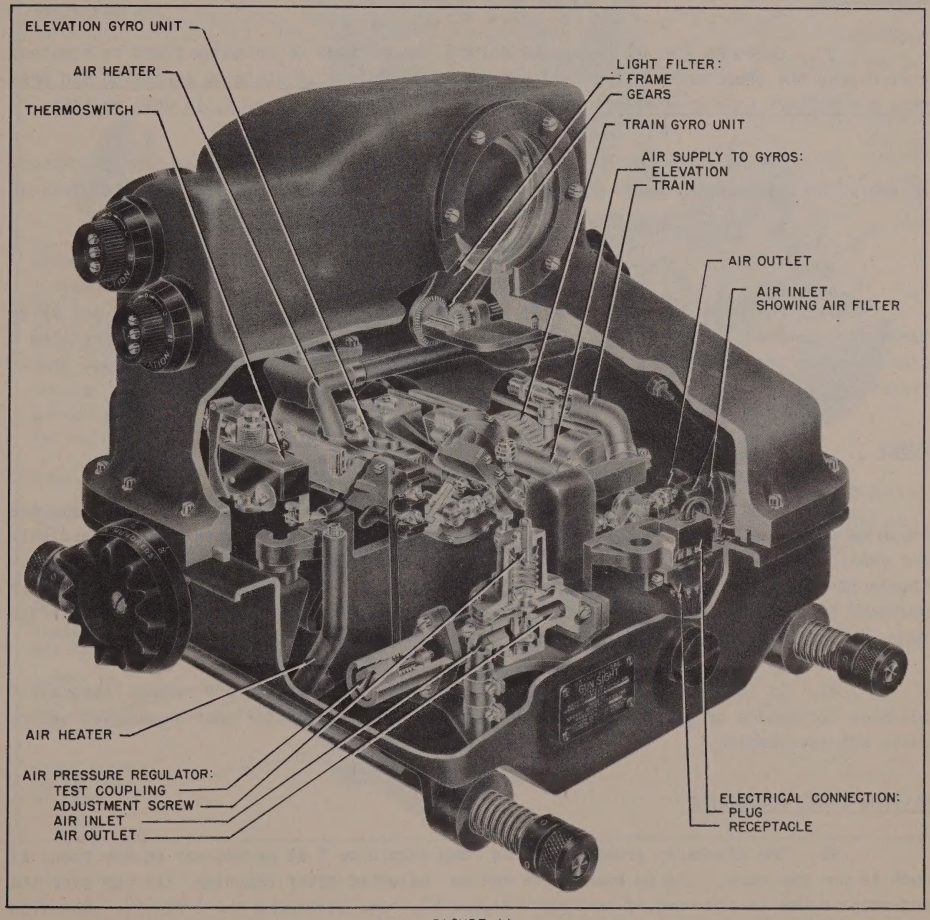


FIGURE 11

GUN SIGHT- FRONT VIEW, SHOWING MECHANISM

85. When replacing lamp in the assembly, care should be taken that the window of the lamp is facing in a direction 90° clockwise with reference to the key on the lamp base, in order that the light may be directed on the reticle.

86. When replacing the spring and cap assembly, the key on the lamp base must be positioned so that it slides into the corresponding groove on the lower side of the lamp socket. Then push down on the assembly cap and turn clockwise as far as it will go. Inspect the gasket on the reticle lamp access cap and replace if necessary. Put access cap back, making sure that gasket is set up airtight.

LUBRICATION

87. Once a week clean and grease the two support rods on which the sight is mounted. Also grease the shock absorber springs and cap nuts. This will minimize corrosion and prevent the support rods from freezing to sight case and support bracket, in cold weather.

88. Moving parts inside the gun sight are adequately lubricated during factory assembly. No lubrication should be attempted, except during overhaul at a service station.

POWER UNIT

89. The power unit is designed to require a minimum of field service and maintenance. However, a few parts require servicing. For this purpose, there is provided a field service tool which is attached to the power unit by means of a chain. This tool facilitates removal of covers.

FUSES

90. Access to fuses and neon indicators may be had by removing the crankcase cover on which is mounted the on-off switch (figure 5). This cover should be removed only for replacement of fuses or for internal servicing when necessary. The special tool mentioned is used to loosen the 4 hexagon nuts holding the cover. A special fuse puller is provided in spare parts box for extracting fuses. The fuses are 5 ampere, midget cartridge type, time delay, known as "Fusetrons".

91. If the pump head and other components are removed for any reason, inspect air passages for traces of dirt or foreign matter. Any foreign matter must be removed before parts are reassembled.

BY-PASS VALVE ADJUSTMENT

92. The discharge pressure of the pump should be 7 ±1 pounds per square inch. If such is not the case, the by-pass valve can be adjusted after removing the cap over the adjusting screw in the head of the pump (figure 5), and loosening the locknut. See also figure 12. To increase the discharge pressure, turn the adjusting screw clockwise; to decrease the pressure, turn the screw counterclockwise. After an adjustment has been made, the locknut must be tightened and the cap replaced.

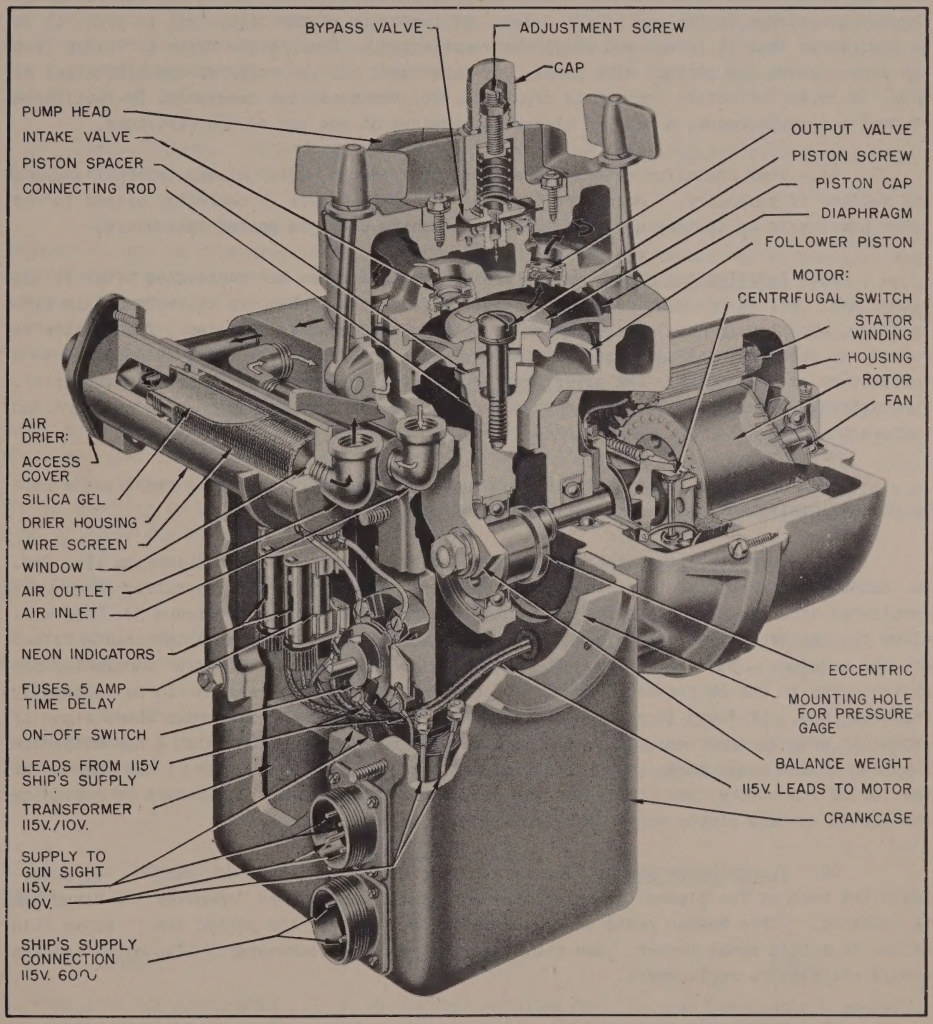


FIGURE 12

POWER UNIT - VIEW SHOWING MECHANISM

REPLACEMENTS

93. Drier. Once every week the drier should be removed for inspection of the condition of the silica gel. To remove drier first remove two nuts holding access cover to drier housing and then pull the drier out from the housing. The silica gel can be viewed through the window at the end of the drier. If the color of the silica gel is pink, it is an indication that it is wet and should be reactivated. Unscrew the drier cartridge from the access cover and replace with spare, dry cartridge. If the color of the silica gel is blue, it is an indication that it is dry, hence, replacement is not necessary. To facilitate removal and replacement, a knurled sleeve is provided at one end of the cartridge.

94. When replacing drier, check condition of the external and internal gaskets and replace if necessary. Make sure that the internal gasket is correctly placed in the drier housing so as to make airtight joint when access cover is pushed into place.

95. Reactivating Silica Gel. This type of drier can be reactivated after it has become wet. Silica gel has the appearance of coarse sand. When dry the material is blue in color, when wet, pink. If the color is pink, slush cartridge in clean, fresh water to remove any salt that may have accumulated. Then place cartridge in an oven heated to a temperature of 300-350° F, but never over 350° F to avoid possible damage to the drier. The cartridge should be left in the oven for 4 hours or more to remove the moisture and restore the blue color.

96. Drier cartridges which are not used immediately after being reactivated must be placed in airtight containers until required for use.

97. Pump Diaphragm. Approximately every two months, the pump diaphragm (Bu. Ord. No. 325354- -2) should be inspected and replaced if necessary. This operation can be accomplished after loosening the two wing nuts on top of the pump head (figure 5). This will allow the two anchor bolts to disengage forks on the head. The pump head then can be lifted off the housing. See figure 12. The diaphragm now may be removed after unscrewing the piston screw in the center and removing the piston cap. The diaphragm should be thoroughly inspected and, if found in good condition, used again. If the diaphragm shows signs of excessive wear or break-through, it should be discarded and replaced with a new diaphragm supplied in the spare parts box. The required fit can be obtained only if the pump is at the top of its stroke, when replacing the diaphragm. Care should be exercised in replacing the piston cap and piston screw to avoid pinching the diaphragm.

98. Piston Screw Washer. The thin rubber washer (Bu. Ord. No. 325380- -8) underneath the head of the piston screw (figure 12) should be replaced whenever the diaphragm is replaced. This washer rests on the countersunk face of the piston cap. Above this washer is a thin metal washer, and above the latter is a lockwasher. The metal washers should not require replacement.

99. Piston Clearance. If the piston cap strikes the cylinder head, the diaphragm and follower piston should be removed, and the piston lockwasher (figure 12) replaced with a thinner washer. If several lockwashers are found underneath the follower piston, removal of one or more of these will correct the difficulty.

100. By-Pass Valve Diaphragm. The diaphragm in the by-pass valve is subject to only a small stress and should have a long life. If through any cause it needs replacement, proceed as follows:

101. Remove the 4 hexagon nuts securing the cover over the by-pass valve, and lift off the cover. This will expose the diaphragm assembly, spring and plug, all of which can be lifted off the pump head. Replace diaphragm assembly (Bu. Ord. No. 325357- -2) comprising a synthetic rubber disc riveted to a metal follower. Set the spring on this, and on the spring set the plug. Replace cover.

102. Valves. Should either the intake or output valve require replacement, proceed as follows:

103. Remove the defective valve by unscrewing it. Special wrenches (Bu. Ord. No. 325502- -4 for the discharge valve, and No. 325503- -1 for the intake valve) are used and are furnished to tenders and base repair stations. Remove old lead gasket and replace with new one from spare parts box. Insert replacement valve, from spare parts box, and screw tightly into place. Assemble pump (see next para.) and operate it to heat the parts, then remove pump head and, using wrench, drive valve more tightly into place.

104. Reassembly. Before replacing the pump head, observe that the intake and exhaust port gaskets are in place between head and housing. Set the pump head in place so that the index pin which protrudes upward from the pump housing, on the side near the pressure gages, fits into a corresponding hole in the head. Re-engage the anchor bolts in the forks, checking that the washers are above the forks. Tighten the wing nuts evenly. The pump is ready for operation again.

LUBRICATION

105. All bearings are of the grease sealed type and should not be dismantled. It is important for the purity of the air supply that no oil be applied to bearings.

106. The connecting rod bearing (running on the eccentric) may become hot and lose its lubricant if the electric motor becomes overheated. If the motor runs at an abnormally high temperature, it should be replaced. In such an event, the connecting rod bearing also should be replaced.

TROUBLE CHART

GENERAL

Trouble	Causes	Remedy
1. Pump does not start when switch is turned on at power unit	a) No current supplied to power unit	a) Check ship's supply circuit
	b) Fuse blown in pump crankcase	b) Replace fuse
	c) Defective starting switch in power unit	c) Power unit must be overhauled at repair station

TROUBLE CHART (Cont'd.)

Trouble	Causes	Remedy
2. Pump starts but reticle lamp does not light (when reticle dimmer is turned up)	a) Reticle lamp burned out	a) Replace lamp with spare (see page 37)
	b) Broken connection in cable connecting pump to sight	b) Check cable connections and test cable
3. Pressure gage on power unit does not read 6 to 8 lb. per sq. in.	a) Leak in pressure hose	a) Check hose fittings
	b) Leak in air drier access cover	b) Check gasket and tighten cover
	c) Restriction in return hose from sight to pump	c) Check for kinks
	d) Defective pump diaphragm	d) Replace diaphragm (page 40)
	e) Incorrect setting of by-pass valve	e) Reset by-pass valve (page 38)
	f) Defective rubber bushings between head and body of pump	f) Replace. They should protrude 1/32", when pump head is removed
	g) Defective by-pass valve diaphragm in head of unit	g) Obtain replacement diaphragm from repair station, and replace (page 41)
	h) Defective intake or output valve in head	h) Replace valve (page 41)
4. Pressure reading (as checked with portable gage) is less than 60 in. of water	a) Pump not delivering 6-8 lb. per sq. in.	a) See remedies under (3) preceding
	b) Leak in pressure hose	b) Check connections at power unit and sight
	c) Sight air filter screen clogged up	c) Remove and clean screen
	d) Restriction in pump air drier unit	d) Remove and clean
	e) Air pressure regulator setting incorrect	e) Reset regulator (page 35)
5. Characteristic time outside limits (page 32)	Thermoswitch set for too high or too low temperature	Reset thermoswitch
6. Sticky reticle or excessive "dead zero" (page 25 , para. 7)	Friction in mirror system or in gyro	Gun sight must be overhauled at repair station

TROUBLE CHART (Cont'd.)

FOGGING OF WINDOWS OR MIRRORS

7. Cause. This trouble is caused by moisture in the air supplied to the sight or oil film forming on window or mirror surfaces.

8. Remedy. This usually requires the removal of front and rear sight windows for cleaning, which should, if possible, be done at a gun sight repair station. In cases where is is not practicable to send sights to repair stations the following procedure is recommended on shipboard.

9. Before attempting to remove front and rear windows for cleaning, try the following: Replace drier cartridge in power unit with reactivated cartridge. Put power unit and sight in operation and permit air to circulate for about one hour.

10. If the method recommended in the previous paragraph failed, it becomes necessary to remove the front and rear sight windows. The sight is first removed from the gun or director and moved into a place where the air is clean and dry. DAMP, SALT AIR MUST NOT BE PERMITTED TO ENTER THE SIGHT.

11. To remove either window, first take out screws, then remove bezel and gasket.

12. Clean windows in a clean solution of soap and water, then rinse with clean water and wipe dry with soft, lintless cloth.

13. Elevation mirror should be cleaned using a high volatility petroleum distillate, such as petroleum ether or Gulf cigar lighter fluid, applied with a soft lintless cloth. Extreme care must be taken, when cleaning, that the mirror is not thrown out of adjustment. Mirror must not be removed from its support.

14. Train mirror should not be cleaned on shipboard. If train mirror requires cleaning, sight must be sent to a gun sight repair station.

15. After cleaning has been completed replace windows. Make sure that gaskets and bezels are set up airtight. Replace sight on gun or director and connect to power unit. Start up and allow to warm up for 30 minutes. Then check sight for performance as outlined under MAINTENANCE.

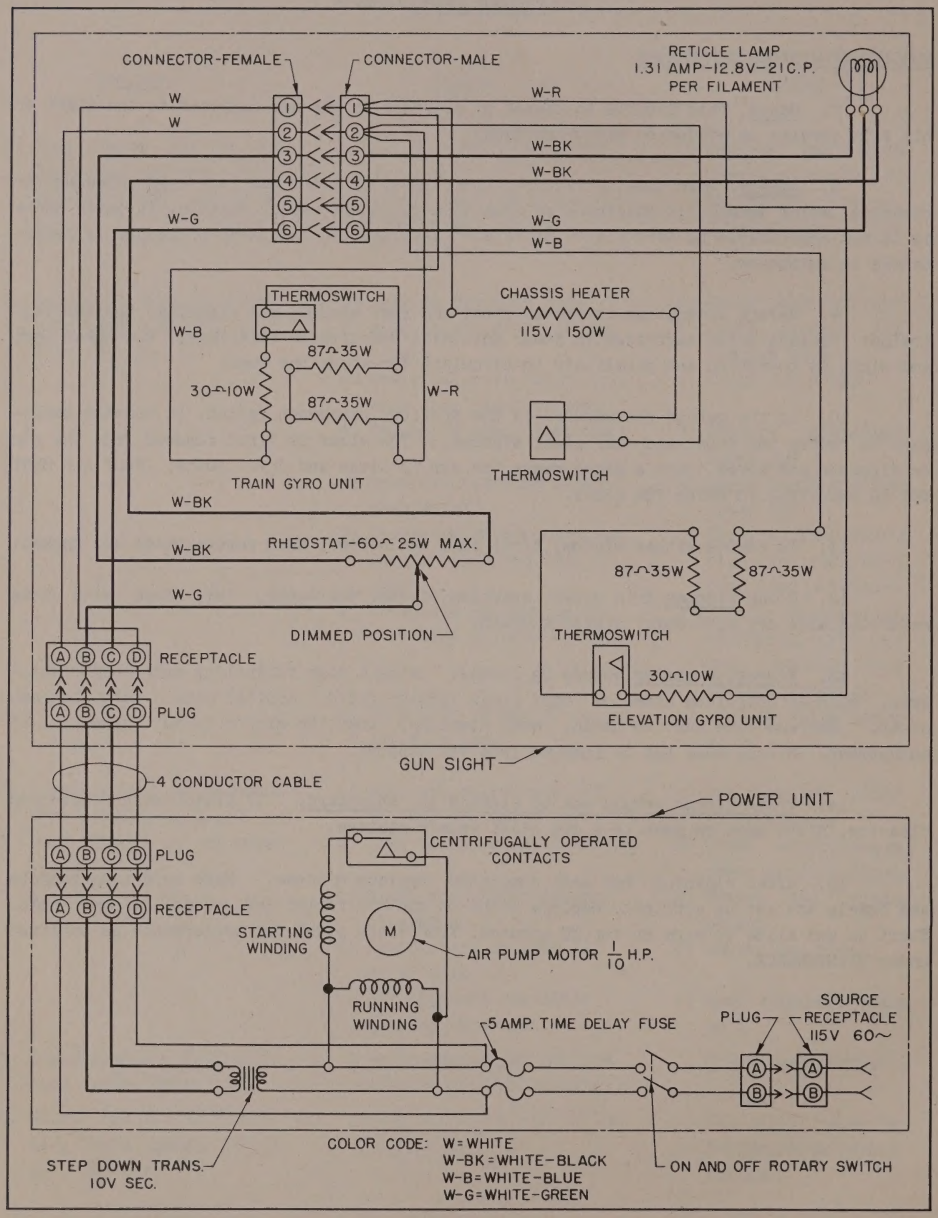


FIGURE 13

SCHEMATIC WIRING DIAGRAM

BU. ORD. #325731- -2 SPERRY #805353

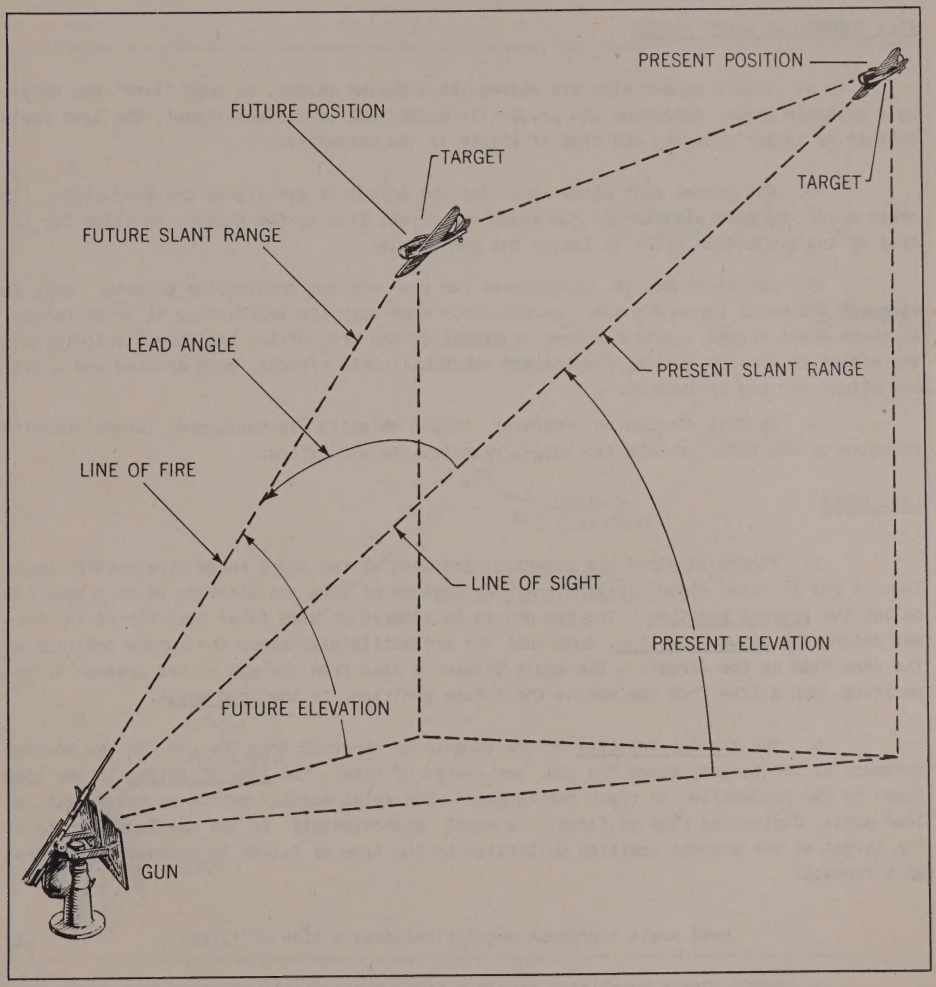


FIGURE 14

FIRE CONTROL PROBLEM - DIAGRAM

CHAPTER V

- BASIC PRINCIPLES -

FIRE CONTROL AT SHORT RANGES

1. When a gunner aims his weapon at a moving target, he must "lead" the target by a suitable angle, otherwise the projectile would fall behind the target. The lead angle depends on target velocity and time of flight of the projectile.

2. The gunner must allow also for the effect of gravity on the projectile. In other words, he must elevate the gun above the direct line to the target, to allow for the drop of the projectile after it leaves the gun muzzle.

3. Gun Sight Mk. 14 is designed for use against fast-moving targets, such as aircraft and motor torpedo boats, particularly when they are approaching at short ranges. At these short ranges, only the time of flight of the projectile, the target velocity and the effect of gravity need be considered; other ballistic effects, such as wind and drift, are slight and can be ignored.

4. In this discussion, wherever target velocity is mentioned, target velocity relative to own ship, or relative target velocity, is understood.

LEAD ANGLE

5. Figure 14 shows the essential features of the short range fire control problem. A gun is fired at an airplane. At the instant of fire the airplane is at a position called the present position. The gun should be pointed at some later position of the target called the future position, such that the projectile will reach the future position at the same time as the target. The angle between a line from the gun to the present target position, and a line from the gun to the future position, is the lead angle.

6. The angular velocity of the target as observed from the gun is the angular movement of the target, about the gun, per second of time. The time of flight is the time taken by the projectile to reach the target. The total angular motion of the target, or lead angle, during the time of flight is equal approximately to the angular velocity of the target at the present position multiplied by the time of flight in seconds. Expressed as a formula:

$$\text{Lead angle} = \text{present angular velocity} \times \text{time of flight} \qquad (1)$$

7. NOTE: Other quantities involved in the fire control problem, such as present and future slant range, are labeled in figure 14.

SUPERELEVATION

8. If the gun bore is pointed at the future position of the target, the projectile will fall below the target because of the downward force of gravity on the projectile. To compensate, the gun elevation is increased by an additional angle called the superelevation angle, as illustrated in figure 15.

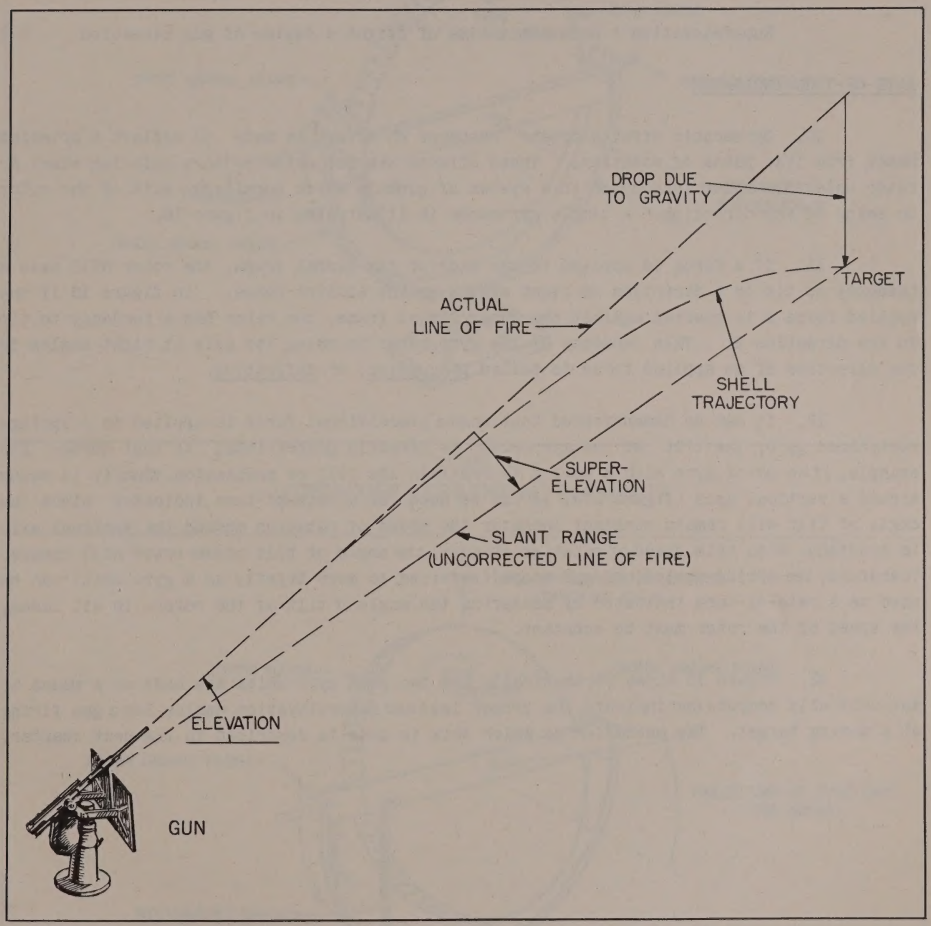


FIGURE 15

SUPERELEVATION DIAGRAM

9. The superelevation angle required is dependent on (a) the ballistics of the gun, (b) the time of flight of the projectile to the target, and (c) the cosine of the angle of elevation of the target. The ballistic data of the gun can be considered constant over short ranges; consequently the superelevation angle can be calculated according to the following equation:

Superelevation = constant x time of flight x cosine of gun elevation (2)

RATE-OF-TURN INDICATOR

10. Gyroscopic effects appear whenever an effort is made to deflect a spinning wheel from its plane of rotation. These effects are not evident in a spinning wheel or rotor unless the rotor is mounted in a system of gimbals which permits the axis of the rotor to swing in any direction. A simple gyroscope is illustrated in figure 16.

11. If a force is applied to one side of the gimbal frame, the rotor will have a tendency to tip in a direction at right angles to the applied force. In figure 16 if the applied force A is exerted against the outer gimbal frame, the rotor has a tendency to tip in the direction B. This tendency of the gyro rotor to swing its axis at right angles to the direction of an applied force is called precession, or deflection.

12. It can be demonstrated that when a precessional force is applied to a spring-restrained gyro, the tilt of the gyro rotor is directly proportional to that force. For example, if we use a gyro with a spring to restrain its tilt or precession, when it is swung around a vertical axis (figure 17), it can be used as a rate-of-turn indicator since the angle of tilt will remain constant whenever the speed of rotation around the vertical axis is constant. When this speed of rotation changes, the angle of tilt of the rotor will change. Therefore, the spring-restrained gyroscope (referred to more briefly as a gyro unit) can be used as a rate-of-turn indicator by measuring the angle of tilt of the rotor. In all cases, the speed of the rotor must be constant.

13. Figure 18 shows schematically how two such gyro units are used as a means to automatically compute and indicate the proper lead and superelevation angles for a gun firing at a moving target. The mechanism by which this is done is described in the next chapter.

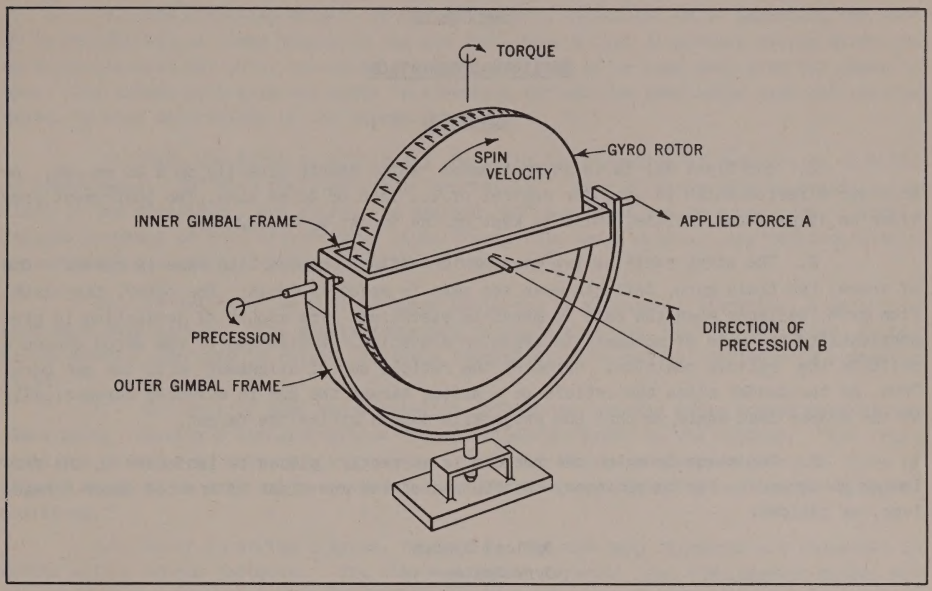


FIGURE 16

GYROSCOPE - ESSENTIAL ELEMENTS

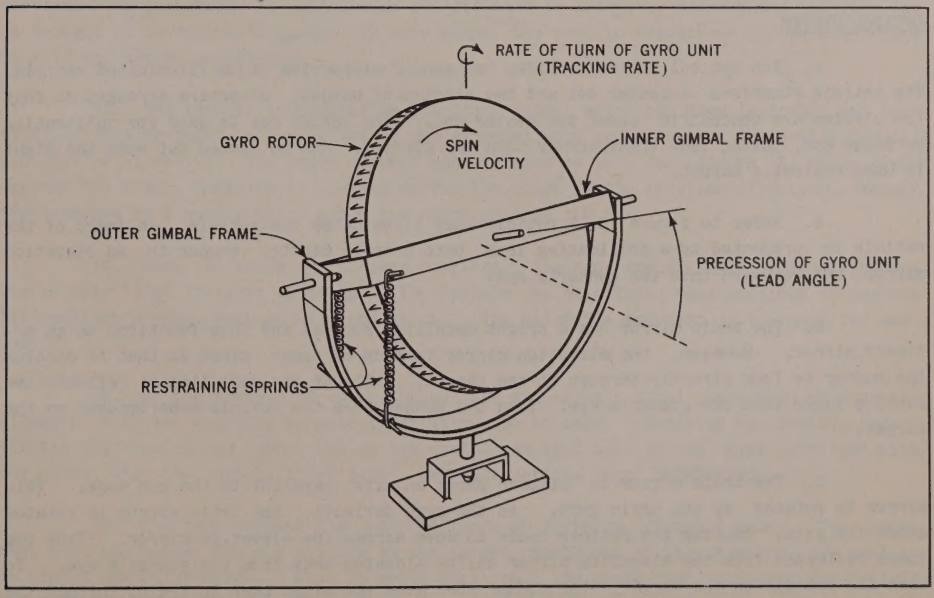


FIGURE 17

SPRING - RESTRAINED GYROSCOPE

CHAPTER VI

- DETAILED DESCRIPTION -

GUN SIGHT

1. Gun Sight Mk. 14 is an instrument which mounts directly on a 20 mm gun, or on a gun director which is used for control of 1.1 inch or 40 mm guns. The instrument provides an illuminated reticle, which is kept on the target by the gunner.

2. The sight contains two gyros which deflect whenever the case is moved. One of these, the train gyro, deflects when the case is moved in train. The other, the elevation gyro, deflects when the case is moved in elevation. The amount of deflection is proportional to the rate of movement in train or elevation. Deflection of the gyros causes a shift in the reticle position, throwing the reticle out of alignment with the gun bore. Thus, as the gunner keeps the reticle on a moving target, the gun is advanced automatically by the proper lead angle so that the projectile should strike the target.

3. The means by which the reticle is correctly placed is indicated in the following paragraphs. For convenience, description of the gun sight is treated under 5 headings, as follows:

Optical System
Gyro System
Range Adjustment System
Air Supply System
Temperature Control System

OPTICAL SYSTEM

4. The optical system provides the gunner with a view of the illuminated reticle. The reticle comprises a center dot and two circles of unequal diameters arranged so that the circles are concentric about the center dot. The center dot is used for calibrating purposes and, having less transparency than the circles, can be dimmed out when the sight is used against a target.

5. Refer to figure 18. A reticle lamp illuminates the reticle. An image of the reticle is projected by a collimating lens onto a train mirror, thence to an elevation mirror, and backward into the gunner's eye.

6. The train mirror has a bright metallic surface and thus functions as an ordinary mirror. However, the elevation mirror is made of clear glass so that it enables the gunner to look directly through at the target, while at the same time it reflects the reticle image into the gunner's eye. Thus the gunner sees the reticle superimposed on the target.

7. The train mirror is pivoted about an axis parallel to the gun bore. This mirror is rotated by the train gyro. As the gyro deflects, the train mirror is rotated about its axis, causing the reticle image to move across the elevation mirror. Thus the image reflected from the elevation mirror shifts sidewise away from the gunner's eye. To keep the reticle on the target, the gunner must move the sight case in train, through the same angle that the reticle has shifted.

8. The elevation mirror is pivoted about a horizontal axis (assuming the case to be horizontal) at right angles to the gun bore. This mirror is rotated by the elevation gyro. As the gyro deflects, the reticle image is shifted up or down, away from the gunner's eye. The gunner must move the sight in elevation through the same angle that the reticle moved, to keep the reticle on the target.

9. When the sight is stationary, the train and elevation mirrors are at an angle of approximately 45° with the light from the reticle. When either mirror is moved to its limit in one direction, the reticle is shifted 25° away from its zero position. Simultaneous movement of both mirrors will cause the reticle image to occupy any position within a frame having a width of 50° and a height of 50°.

10. To maintain the reticle image unblurred by mechanical vibration, a damper is used with each mirror. The damper comprises a circular disc, rigidly connected to the mirror shaft, arranged to rotate inside a housing which is partly filled with a damping fluid.

11. The reticle lamp has a metallic reflecting coating which covers most of the glass bulb, leaving a circular window for directing the light on the reticle. Two filaments are provided so that if one burns out, the other can be connected instantly. This is done by means of an external knob which has an OFF (center) position and two BR (bright) positions.

12. Refer to wiring diagram, figure 13. The two lamp filaments are connected in series with a 60-ohm rheostat. The common filament terminal and the rheostat slider are connected to the 10 volt a-c supply from a transformer in the power unit. When the slider is at the mid-point of the rheostat, 30 ohms of resistance is in series with each lamp filament so that the lamp is practically extinguished. As the knob is turned in either direction, the resistance in series with one filament is gradually reduced and the lamp can be brought up to full brilliance. By this means, the reticle brightness can be controlled to suit any target background.

13. The reticle is mounted on a sliding block which can move laterally and vertically. This movement is controlled by two external spot knobs, one for deflection (train) and one for elevation. The shaft of each knob terminates in a cam (figure 18) which rests against the block. Rotation of the cam shifts the block in the required direction, against the pressure of a spring which holds the block against the cam.

14. When the knobs are at zero position, the cams are at their mid-position and the reticle is at its zero position. The reticle can be offset when required to correct for constant errors, such as wind and drift. The allowable movement is ±25 mils for each knob.

15. In the process of boresighting the gun sight, final correction of any misalignment with the gun bore is made by shifting the reticle. Shifting the reticle necessitates shifting of the spot knob on its shaft, so that zero on the knob coincides with the index, when the reticle is at zero. See instructions under MAINTENANCE.

16. The lens focuses the reticle image an infinite distance away. This means that when the gunner focuses his eye on the target, regardless of its distance, the reticle is always sharply focused. Also it means that once the gunner has centered the reticle on the target, the reticle will not shift away from the target if the gunner moves his head slightly in any direction. In other words, parallax is eliminated.

17. A light filter (figure 11) is provided inside the gun sight case, for use when desired to reduce glare due to direct sunlight, water reflection, etc. The position of the filter is controlled by means of the filter lever (figure 4). A spring detent on the filter holds it in either of two positions, in front of the sight window or away from it. The filter is gray colored and has the property of polarizing the light, for more effective control of glare.

GYRO SYSTEM

18. The gyro system comprises two gyro units, one for train and one for elevation, which deflect as the gun (or director) is moved when tracking a target.

19. Each gyro unit has an air-driven rotor supported by ball bearings in a gimbal frame. The gimbal frame in turn is supported in a housing by a frictionless spring suspension.

20. Attached to each end of the gimbal frame is a damping disc which is enclosed by a chamber partly filled with damping fluid. The fluid acts as a drag on the disc and thereby slows the gyro response. This enables the gunner to follow smoothly a rapidly moving target. Also the fluid damps any vibration of the gyro.

21. The damping discs absorb the effects of heavy vibration and shock and thus relieve the spring suspension.

22. When the train axis of the gun is vertical and the gun bore is horizontal, the spin axis of the train gyro unit is horizontal and the spin axis of the elevation gyro unit is vertical. Both spin axes are perpendicular to the gun bore.

23. Refer to figure 18. The train gyro controls the angular position of the train mirror by means of the train gyro lever which is rigidly attached to the gyro gimbal frame. The train gyro lever carries a fork at its outer end which engages a ball attached to the train mirror crank. The mechanical drive for the elevation mirror is similar to that of the train mirror, except that the elevation bell crank is placed in the system so as to permit operation of the mirror about an axis perpendicular to the elevation gyro axis.

24. The mechanical arrangement described moves the mirrors in such a fashion that the lead angles in train and elevation as indicated by the reticle are proportional to the deflection of the gyro units in train and elevation respectively.

25. In order to introduce a superelevation component, a superelevation weight (figure 18) is provided in the front gimbal suspension system of the elevation gyro. The weight is threaded on a shaft extending to one side of the gimbal axis. When the gun is horizontal, the deflection of the gyro caused by the weight is a maximum. As the gun is elevated, the effect of the weight decreases, becoming zero when the gun is pointed to the zenith (where the trajectory droop is zero).

26. In the gun sight, both train and elevation gyros are fitted with identical superelevation weights. The weight for the train gyro is directly above the gimbal axis when the gun platform is horizontal and the gun bore is horizontal. This construction makes it possible for the two gyros to interchange functions, so far as superelevation is con-

cerned, if the sight in which the gyros are mounted is tilted away from the vertical about a line parallel to the gun barrel. Such tilting may happen when the ship rolls.

27. The superelevation component is introduced independently of the lead angle. Thus if the gun sight is stationary, the reticle is positioned according to the amount of superelevation. When the sight is moved, as in following a target, the gyro unit is deflected an additional amount according to the rate of movement. The resultant reticle position represents a combination of superelevation and lead angle.

RANGE ADJUSTMENT SYSTEM

28. Range adjustments are set into the sight by movement of the range knob (figures 9 and 18). This causes equal rotation of the two range gears, one at each gyro unit. Each range gear causes a set of range springs, shown in the figure, to move in or out and thereby offer more or less resistance to deflection of the gyro unit.

29. When the range knob is turned to a low range setting, the range springs are shifted toward the center and the resulting gyro deflection, due to movement of the gun sight case, is small. Thus the reticle movement is small and the resulting lead angle is small.

30. When the range knob is turned to a high range setting, the range springs are shifted away from the center and the gyro deflection is large. This gives a large lead angle, as required for the greater range.

31. The range setting also affects the superelevation component. Thus, when the range knob is turned to a low value, the range spring position is such as to permit a small deflection of the gyro, due to the superelevation weight. This gives a small superelevation component. When the range knob is turned to a high value, the range springs permit a large deflection of the gyro, due to the superelevation weight. This gives a large superelevation component, as required for the greater range.

32. The range knob carries a scale which moves past an arrowhead index to indicate the value set into the sight. As the knob is moved, a detent is engaged at each 400-yard interval.

AIR SUPPLY SYSTEM

33. Proper operation of the sight requires that the gyro rotors operate at constant speed. This will be realized if the rotors are driven by clean, dry air at constant pressure and temperature. These requirements are met by the air supply system.

34. Air is supplied from the power unit and enters the gun sight case at about 7 pounds per square inch pressure. It passes through a filter (figure 11) which removes all traces of dust. Next the air passes through a long tube where its temperature is raised to approximately that of the gyro unit. The method of heating the air is described in para. 41 of this Chapter.

35. After being heated, the air is led to a pressure regulator which eliminates the effects of supply pressure variation. From the pressure regulator, a supply tube leads to the nozzle in each gyro unit. A needle valve, in the nozzle, provides accurate adjustment of rotor speed as a means of matching the deflection of the train and elevation gyros.

36. The pressure regulator is provided with a test coupling (figure 11) for attaching a portable pressure gage. Thus the pressure applied to the nozzles can be read when required. One or more pressure gages are provided for each ship. The pressure through the regulator should be between 60 and 62 inches of water pressure. This is indicated on the portable gage when the pointer is within the green sector of the scale.

37. From the gyro units, the air is exhausted into the gun sight case and is led through the air outlet and thence back to the power unit. In the power unit, the air passes through a drier, in the outlet line, which removes moisture from the air. This eliminates any possibility of the sight windows becoming fogged internally, due to moisture.

38. The gun sight case is of airtight construction, except for the air inlet and outlet which are connected to the power unit. All removable covers are provided with gaskets, and the external knob and range knob shafts are fitted with stuffing boxes.

TEMPERATURE CONTROL SYSTEM

39. It is essential that the gyro units and the air supply be maintained at constant temperature, for proper operation of the sight. This function is performed by the temperature control system.

40. The response of the gyro unit depends partly on the damping action, and this in turn depends on the viscosity of the damping fluid. To stabilize the viscosity, the temperature must be held constant (at about 140° F).

41. To stabilize the gyro rotor speed, the supply air must be held to constant temperature. A long tubular heater (figure 11), rated 150 watts at 115 volts, is provided for this purpose. The heater is clamped to the chassis; the air tube (para. 34) is clamped to the chassis also, thus heat is transferred from the heater through the chassis to the air tube.

42. The heater serves also to keep the temperature within the sight case at the proper value. A thermostat, in series with the heater, connects or disconnects the heater as required, thus maintaining the temperature within the proper limits.

43. Constant temperature of the damping fluid in each gyro unit is maintained by two heaters fastened to the two damping disc housings, and controlled by a thermoswitch which is supported in the gyro unit housing. Refer to wiring diagram, figure 13. The two heaters mentioned are designated as 87 ohms each. An additional heater of 30 ohms is placed close to the thermoswitch, for sensitive control of the heating action. The 3 heaters and the thermoswitch at each gyro unit are connected in series and thence to the 115 volt a-c supply.

44. When the electrical supply is disconnected, the thermoswitch contacts are closed. Energizing the circuit causes the heaters to warm up. When the temperature rises to the operating value, the thermoswitch contacts open. Thereafter the contacts repeatedly close and open as required to maintain operating temperature.

CASE

45. Projections on the bottom of the case are drilled and reamed to fit support rods which carry the weight of the sight. The case slides on the rods, against the restraint of shock absorber springs, so as to minimize the effect of longitudinal shocks caused by the gun under service conditions.

POWER UNIT

46. The function of the power unit (figures 5 and 12) is to supply compressed air, cleaned and dried, to the sight for driving the gyros. The unit includes a transformer to reduce the ship's supply voltage to 10 volts for energizing the reticle lamp. Terminals are provided within the unit for connecting the ship's 115 volt single phase a-c supply to the sight for operation of the heaters and thermostats. The 10 volt and 115 volt supplies are led from the power unit to the sight through a 4-conductor cable. The ship's 115 volt, single phase supply is led to the power unit through a 20 foot two-conductor cable leading to an outlet on the gun pedestal. (The power units which are mounted on Gun Director Mk. 51 are connected through a shorter cable which leads from the director head.)

47. The crankcase of the power unit serves as a housing for the transformer, two-pole rotary switch, fuse block and pressure gage. The crankcase is clean and free of oil and operates at atmospheric pressure.

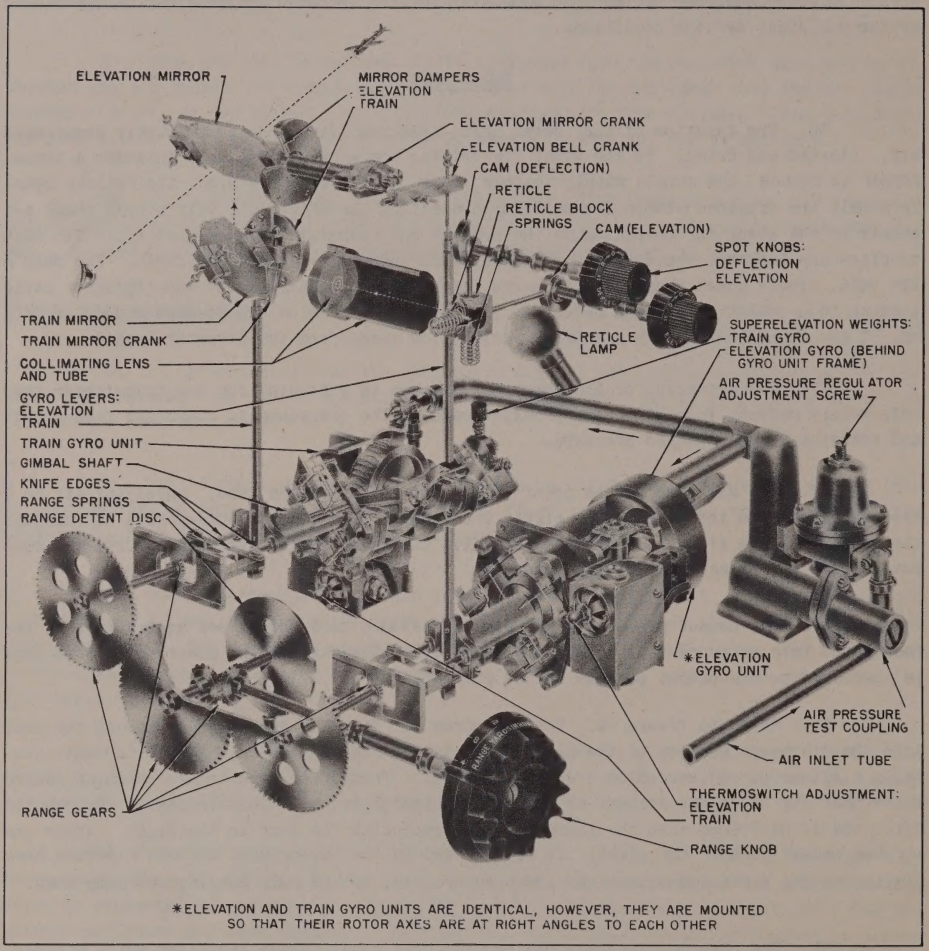
48. The air pump of the power unit is of the diaphragm type, supplying air to a closed system from the pump to the sight. The head incorporates a by-pass valve to regulate the pressure. See figure 12. The by-pass valve allows excess air to be bled from the output side to the intake side of the pump.

49. The output pressure of the pump is set at 6 to 8 pounds per square inch at the factory. This pressure is indicated on the dial of the gage on the power unit. The gage is connected to the output passage in the pump head.

50. Refer to figure 12. The discharge air from the pump passes through the head into the discharge section of the housing and thence into the drier. The latter unit contains a filter screen enclosing a chemical drier. This drier absorbs any entrained water vapor that may be in the system at the time of installation. The air passes through the drier and is delivered into the pressure hose connecting the pump to the sight. After the air has passed through the sight, it is returned to the power unit through a second hose similar to the first and enters the low pressure side of the pump housing and pump head.

51. The pump is direct-driven by a 115-volt single phase induction motor of waterproof construction, operating at 1750 rpm. The motor stator has a running winding which is energized continuously (when the circuit is connected), and a starting winding which is connected, through centrifugally operated contacts, when the motor is stopped or below normal speed.

52. Mounted on the rotor shaft is an eccentric which actuates a connecting rod. The connecting rod in turn actuates the diaphragm and thus causes the pumping action. As shown in figure 12, the motor shaft and the eccentric are provided with grease sealed ball bearings.



*ELEVATION AND TRAIN GYRO UNITS ARE IDENTICAL, HOWEVER, THEY ARE MOUNTED SO THAT THEIR ROTOR AXES ARE AT RIGHT ANGLES TO EACH OTHER

FIGURE 18

GUN SIGHT-SCHEMATIC DIAGRAM

TO SIMPLIFY THE ILLUSTRATION, THE WIRING, AIR HEATER AND PART OF AIR SUPPLY TUBE ARE OMITTED.

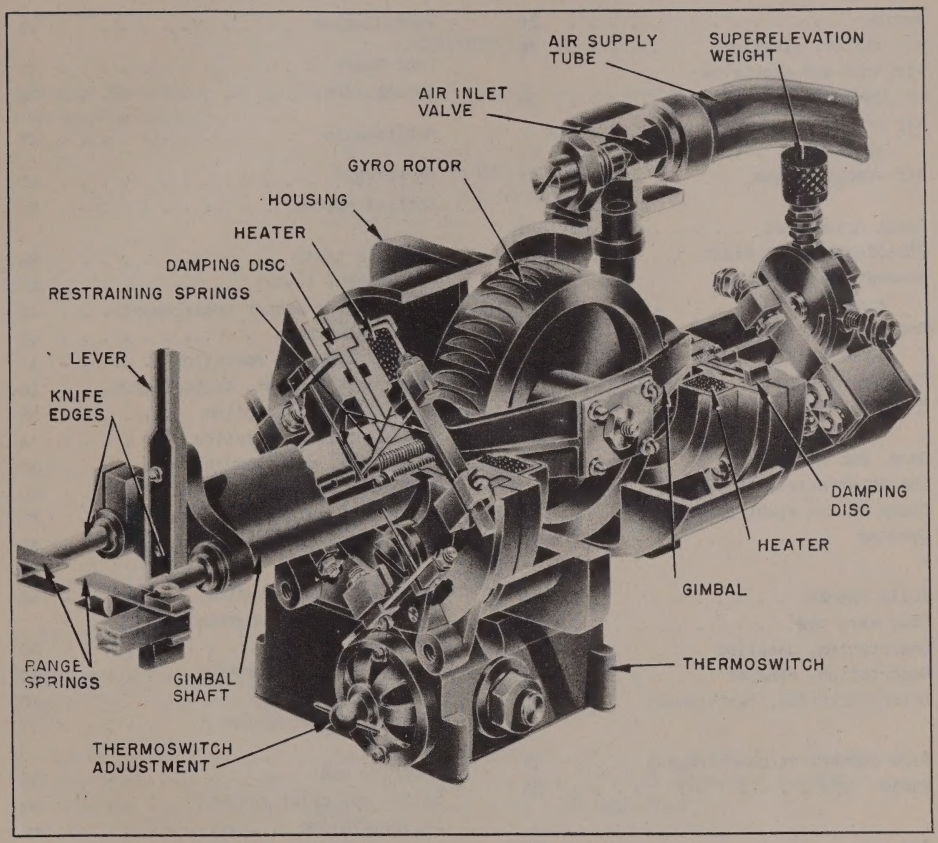


FIGURE 19

GYRO UNIT-VIEW SHOWING MECHANISM

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